SUGARBEET RESEARCH

1972 REPORT

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A Report to and for
the Sole Use of Cooperators

NOT FOR PUBLICATION

FOREWORD

SUGARBEET RESEARCH is an annual compilation of research accomplishments by Agricultural Research Service investigators and cooperators who are engaged in sugarbeet variety and production research. The report has been assembled by Dr. John S. McFarlane, Technical Advisor for sugarbeet variety and production research in the Western Region of the Agricultural Research Service. The report has been reproduced at the expense of the Beet Sugar Development Foundation, and is for the sole use of the cooperators. Much of the data has not been sufficiently confirmed to justify general release and interpretations may be modified with additional experimentation. The report is not intended for publication and should not be used for cited reference nor quoted in publicity or advertising. Reproduction of any portion of the material contained herein will not be permitted without the specific consent of the contributor or contributors.

The report presents results of investigations strengthened by contributions received under Cooperative Agreements between Agricultural Research Service, U.S. Department of Agriculture, and the Beet Sugar Development Foundation; the California Beet Growers Association, Ltd.; the Farmers and Manufacturers Beet Sugar Association; and the Red River Valley Sugarbeet Growers Association, Inc.

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ABSTRACTS OF PAPERS APPROVED FOR PUBLICATION

BEATTY, K. D. and C. F. EHLIG. A technique for testing and selecting for salt tolerance in sugarbeet. (Approved by ARS for publication in J. Am. Soc. Sugar Beet Technol.)

A simple and reproducible technique in sand culture was developed for evaluating the salt tolerance of sugarbeets at the stages of seed germination and seedling emergence. Mean germination and the standard deviation of the mean with sand culture were the same as with petri dishes. Sand culture permitted easy transfer of seedlings to other containers for propagation. The technique could be used to evaluate the salt tolerance of other crops in addition to sugarbeets.

BENNETT, C. W. A consideration of some of the factors important in the growth of the science of plant pathology. Ann. Rev. Plant Pathol. (In press).

The author reviews the early history of plant virus research and of the American Phytopathological Society.

BUGBEE, WILLIAM M. Pectolytic enzyme production by Phoma betae. Can. J. Bot. 50: 1705-1709. 1972.

Phoma betae from decayed sugarbeet storage root tissue grew most rapidly in culture at 15C but produced more polygalacturonase (PG) at 20C. When the fungus was supplied with six different nitrogen sources, it produced the most PG on $(NH_4)_2SO_4$.

Assays of dialyzed culture filtrates using sodium polypectate and pectin or cell wall material from storage roots as the carbon sources showed the production of exopolygalacturonase (exo-PG) and endopolygalacturonate trans-eliminase (endo-PGTE). No pectin methyl esterase was detected. Exo-PG and endo-PGTE also were present in decayed sugarbeet tissue. Only endo-PGTE was detected within 3 mm of tissue surrounding the rotted area.

In culture, cell wall material from the susceptible variety A58 induced more endo-PGTE formation than the resistant 2B. But 2B induced more exo-PG formation than A58. It is suggested that endo-PGTE plays a major role in cell wall degradation because pH 7.5 was optimum for tissue maceration and pH 8.5 for enzyme activity and the advancing margins of rotted tissue contained only endo-PGTE.

BUGBEE, W. M. Sucrose and cell walls as factors affecting Phoma storage rot of sugarbeet. Phytopathology (In press).

Sucrose concentration and resistance of sugarbeet storage roots to *Phoma betae* increased with age. Growth of *P. betae* on isolated cell wall material in culture also increased with the age of roots, but the

production of endopolygalacturonate trans-eliminase (endoPGTE) decreased up to 142 days, then increased. Cell walls from a fodder cultivar induced more endoPGTE than cell walls from two sugar cultivars. Commercial cultivars that were higher in sugar remained resistant, whereas the low sugar, fodder cultivar became more susceptible.

There was a significant negative correlation between the sucrose percentage and disease rating of defoliated and nondefoliated plants. Phoma betae produced more endoPGTE when cultured on cell wall material from defoliated than from nondefoliated plants. Enzyme production was not affected by sucrose percentage of root tissue or cultivar. Individual roots that expressed a resistant reaction to P. betae usually had a high sucrose percentage. But the association of resistant roots with resistance to maceration by culture filtrates and the production of endoPGTE on isolated cell wall material suggest that the properties of cell walls as well as sucrose content affect pathogenesis and the activity of endoPGTE.

BUGBEE, W. M. Resistance in Beta vulgaris to phoma storage rot in the North Central region. Plant Dis. Reptr. (In press).

A survey of sugarbeet cultivars being introduced or grown in the Red River Valley of North Dakota and Minnesota shows that none possess resistance to storage rot caused by Phoma betae. Selection for resistance should be done at 20-25C because varietal differences may not be apparent at 10-15C.

DUFFUS, JAMES E. Infectivity neutralization and membrane feeding: serological comparison of circulative viruses. Intern. Virol. 2: 253-254. Proc. 2nd Intern. Congr. Virol. 1971.

A number of viruses which are transmitted circulatively by their aphid vectors have certain host plants and host reactions in common (beet western yellows virus, beet mild yellowing virus, potato leaf roll virus, turnip latent virus, Physalis mild chlorosis virus, turnip yellows virus, malva yellows virus, etc.). Others have distinctive host reactions but have very similar vector relationships (barley yellow dwarf virus, carrot red leaf virus, filaree red leaf virus, etc.). Valuable in virus diagnosis as are such criteria as vector relations, symptom expression, and host range, there is sufficient ambiguity in many results to indicate the need for independent evidence such as serological evidence. The specificity of serological reactions would make serological diagnosis especially valuable for these yellowing type viruses. Neutralization of infectivity by immune sera, tested by using insect vectors fed through membranes on the virus-antiserum reactants has been shown to be extremely sensitive and to have application for the study of the relationships of several circulative insect-transmitted viruses.

DUFFUS, JAMES E. and G. E. RUSSELL. Serological relationship between beet western yellows and turnip yellows viruses. Phytopathology 62: 1274-1277. 1972.

A possible relationship between beet western yellows virus (BWYV) and turnip yellows virus (TuYV) was indicated by the similarities of symptom expression and transmission characteristics of the two viruses, and was further supported by the recent demonstration of the occurrence of BWYV in Europe. A TuYV isolate from turnip in England was transmitted by *Myzus persicae* to *Capsella bursa-pastoris* and studied in regard to host range, transmission, and serology. The reaction on certain key indicator hosts was similar to that of English isolates of BWYV. *Beta vulgaris*, *Raphanus sativus*, *Brassica pekinensis*, *Chenopodium capitatum*, and *Sonchus oleraceus* were immune to TuYV, and *Brassica rapa*, *Lactuca sativa*, *Capsella bursa-pastoris*, *Nicotiana clevelandii*, *Senecio vulgaris*, and *Claytonia perfoliata* were susceptible. TuYV was readily transmitted by *M. persicae*, which had acquired virus by feeding on clarified sap through artificial membranes. In density-gradient columns containing sap from infected plants, the positions of infectious zones corresponded closely with those in gradients containing BWYV. Antisera prepared against eight strains of BWYV from America and England neutralized infectivity of TuYV. Antisera prepared against TuYV from England neutralized infectivity of nine BWYV strains from America and England and TuYV isolates from England and Germany. The results of these investigations establish a close serological relationship between BWYV from America and England and TuYV from turnip in England and Germany.

HECKER, R. J., TALAT BILGEN, P. S. BHATNAGAR, and G. A. SMITH. Tests for chemical induction of male sterility in sugarbeet. Can. J. Plant Sci. 52: 937-940. 1972.

We conducted four greenhouse and field experiments on the evaluation of 2-chloroethylphosphonic acid (Ethrel), estrone, dimethylarsinic acid, and 2,3-dichloroisobutyrate (FW-450) as male gametocides on sugarbeet (*Beta vulgaris* L.). Estrone induced a significant amount of pollen sterility in three genotype-treatment combinations, but the amount of emasculation was not sufficient or consistent enough to be of practical value. Dimethylarsinic acid had no gametocidal effect. FW-450 effected the greatest amount of pollen sterility, but was considered inadequate as a commercial gametocide. Ethrel induced varying amounts of pollen sterility, dependent upon genotype. At 200 ppm it was phytotoxic and reduced seed yield drastically. It is doubtful that Ethrel will be useful as a gametocide in sugarbeet.

LEWELLEN, R. T. Inheritance of beet mosaic virus resistance in sugarbeet. (Accepted for publication by Phytopathology)

An annual line of sugarbeet (*Beta vulgaris*) was shown to be a source of beet mosaic virus (BMV) resistance. Inheritance studies indicated that one incompletely dominant gene, *Bm*, conditioned resistance. Local lesion counts on *Chenopodium amaranticolor* from BMV infected

sugarbeet sources showed that the concentration of virus was reduced by the Bm gene and that the heterozygous F_1 was intermediate in concentration. Bm was specific against all isolates of BMV tested but appeared to have no effect on systemic infection by other beet viruses.

MAAG, G. W., R. J. HECKER, and P. A. WHITAKER. Nitrogenous compounds in sugarbeet juices. (Accepted for publication by J. Am. Soc. Sugar Beet Technol.)

Juices from sugarbeets (Beta vulgaris L.), grown at three nitrogen (N) fertility levels, were analyzed for individual N constituents. Over 93% of the total N was identified in twenty-one amino acids, two amides, betaine, ammonia, and nitrates. The amino N in the amino acids and amides accounted for about 33% of the total N; glutamic acid and glutamine contained about 63% of the amino N. Up to 36% of the total N was found in betaine, a nitrogenous base. The total N and amino N showed a significant increase with each N fertility increase. Betaine N did not increase significantly because of N fertility treatments; ammonium and nitrate N each showed a significant difference between the low and high N treatments only.

MAAG, G. W., D. M. RASMUSON, R. J. HECKER, and E. G. RUPPEL. Amino acids associated with Cercospora leaf spot resistance in sugarbeet. (Approved by ARS for publication in Phytopathology)

Twenty-two amino acids and two amides were determined quantitatively by automated analysis of leaves collected on three sampling dates from six field-grown and disease-free sugarbeet cultivars. The cultivars were selected to give a wide range of resistance to Cercospora beticola. Results showed L-3,4-dihydroxyphenylalanine (DOPA) to be significantly higher in the resistant cultivars at all sampling dates. L-glutamic acid was significantly higher in the susceptible cultivars. Use of a linear summary variate based on glutamic acid and DOPA data showed the probability of correctly classifying a cultivar as resistant or susceptible was .813. The mode of action of the amino acids in the disease mechanism was not determined.

McFARLANE, J. S. Factors affecting sugarbeet seed germination in North America. (Approved by ARS for publication in J. of the Intern. Inst. for Sugar Beet Research)

A review paper discussing research on cultural and environmental influences on germination, inhibitory substances, physical restrictions on germination, underdeveloped seeds, seed maturity and harvesting, and heritable differences in germination.

MUMFORD, DAVID L. A new method of mechanically transmitting curly top virus. Phytopathology 62: 1217-1218. 1972.

Curly top virus was mechanically transmitted to sugarbeet by an injector instrument normally used in human mass immunization programs. Fifty per cent infection was obtained when 48-day-old plants were inoculated with a single injection into the crown of each plant.

SMITH, G. A. and R. J. HECKER. Components of yield of recoverable sugar in random and improved sugarbeet populations. (Approved by ARS for publication in Can. J. Plant Sci.)

Path coefficient analyses indicated that selection and other breeding procedures alter the relative importance of characters that determine recoverable sugar yield in sugarbeet.

Root weight was a more important yield component than sucrose percentage and over twice as important as purity in an unselected population.

Root weight and sucrose percentage contributed about equally in improved populations, but the importance of both to recoverable sugar was substantially greater than in the unselected population. Purity was about twice as important a component in the improved population as it was in the unselected population. Results suggest that the emphasis of breeding programs will need to change with changes in the genetic structure of the improved population.

Because of the lack of negative indirect effects in the commercial population, the association of recoverable sugar and sucrose % was nearly twice as high as compared to the relatively unimproved random hybrid population.

SMITH, G. A., R. J. HECKER, G. W. MAAG, and D. M. RASMUSON. Combining ability and gene action estimates in an eight parent diallel cross of sugarbeet. (Accepted for publication by Crop Sci.)

Twenty-eight F_1 hybrids from an 8 parent diallel cross grown at two nitrogen fertility levels were analyzed for type of gene action controlling eleven sugarbeet (*Beta vulgaris* L.) characters. Nonadditive genetic variance was of prime importance in controlling root weight under low and high nitrogen levels, accounting for 51% and 68% of the total genetic variance, respectively. For recoverable sugar, nonadditive genetic variance accounted for 67% and 83% of the total genetic variance under low and high nitrogen. Additive genetic variance accounted for most of the genetic variance for sucrose percentage and root/shoot ratio. Both additive and nonadditive genetic variance were significant for thin juice purity %, but only at the high nitrogen fertility level.

Additive genetic variance was predominant for six nonsucrose components of purified juice. In addition, significant amounts of nonadditive gene action were found for all six nonsucrose components at one or both nitrogen levels. Betaine was the least affected by change in nitrogen of all the characters measured.

STEELE, A. E., J. THOMPSON, and G. WHEATLEY. Depth of application and efficacy of soil nematicides for controlling Heterodera schachtii. Plant Dis. Reptr. 55: 1101-1105. 1971.

In three separate tests, deep applications of 1,3-dichloropropene, 1,2-dichloropropane mixture at 14-18 inches below the soil surface failed to significantly increase control of Heterodera schachtii Schmidt 1871 on sugarbeet or broccoli. Control of the sugarbeet nematode was obtained by 20, 25 or 30 gal./A of these chemicals, although significant differences between chemicals or rates of application were not apparent. Yields of sugarbeet and sucrose in treated plots were similar to those in untreated plots in one test and significantly better than untreated plots in another test. The highest yields of broccoli were obtained from plots treated with 30 gal./A of 1,3-dichloropropene applied 18 inches below the soil surface.

STEELE, A. E. Orientation and development of sugarbeet nematode larvae on tomato and sugarbeet. J. Nematology 3: 424-426. 1971.

A study was made to clarify and extend the information on orientation and development of larvae on tomato and sugarbeet. Second stage larvae, third and fourth stage males, and young adult males of Heterodera schachtii were found on the external surfaces of primary and secondary roots of sugarbeet and tomato examined at intervals of 20 - 117 days after inoculation with cysts containing eggs and larvae. There was a great variation in the degree of penetration of larvae within host roots so that their parasitic habit varied from complete endoparasitism to nearly complete ectoparasitism with only the cephalic region buried in the root. All of the larvae external to the roots which were sexually differentiated were males with the exception of a single third stage female. The number of male larvae on root surfaces never exceeded an estimated 10% of the total population on a given plant. All stages of male larvae were found external and attached to lateral roots of sugarbeets obtained from a commercial field at harvest, 6½ months after planting. Counts revealed that 46% of the larvae were oriented with their anterior ends toward the root tip, 44% with their anterior ends toward the hypocotyl and 10% were oriented nearly perpendicular to the root axis. Since males are located more superficially on host-plant roots than females, successful development of the latter may be greatly influenced by factors affecting penetration of host roots.

STEELE, A. E. Invasion of non-host plant roots by larvae of the sugarbeet nematode Heterodera schachtii. J. Am. Soc. Sugar Beet Technol. 16: 457-460. 1971.

An investigation established that larvae of the sugarbeet nematode readily penetrates diverse non-hosts, such as sunflower, morning glory, parsley, egg plant, celeriac, and sweet pea, but does not develop to maturity on these plants. This finding suggests the possibility that

many non-hosts may, to some extent, trap migrating second-stage larvae, and that even in non-hosts, invading larvae may provide an avenue for invasion of pathogens. Mature females with developing eggs were found on at least one plant of each of three 'non-host' species. This suggests that such occasional development of the sugarbeet nematode on highly resistant species can, and perhaps does, maintain localized areas of low level infestations which became detectable only after continuous cropping of susceptible host plants. On the other hand, truly immune plants, when used in rotations may actually reduce the nematode population at much greater than normal decline rate by having a trap-crop effect.

STEELE, A. E. Morphological changes in roots of sugarbeet and tomato infected with Heterodera schachtii Schmidt 1871. J. Am. Soc. Sugar Beet Technol. 16: 561-567. 1971.

Examination of roots of sugarbeet and swiss chard revealed that these roots frequently contain breaks in the cortical tissues which vary from fine fissures to cracks and showed extensive sloughing of the epidermis and cortical parenchyma (normal occurrences). Both infected and non-infected roots often contained deep cracks which extended through the cortex to the central cylinder. Deep cracking frequently occurred in areas where roots were bent or twisted out of line with the root axis. In many instances, swollen female sugarbeet nematodes were found deep within cracks and within the shallow rifts where lateral roots emerged from tap roots. A total of 12 maturing juvenile males and females were found within a single elongated rift in the hypocotyl of a sugarbeet 17 days after transplanting to soil infested with 50 cysts. The plant was extremely stunted and the roots were heavily parasitized by larvae. Roots of resistant B. patellaris and immune B. webbiana grown in infested or sterilized soil for 20 to 40 days showed extensive sloughing of epidermis without sloughing of cortical parenchyma or formation of rifts. These abnormal changes in the gross morphology of infected sugarbeet roots have never been reported in the literature.

STEELE, A. E. The influence of dilution on the hatching activity of sugarbeet-root diffusate. J. Am. Soc. Sugar Beet Technol. 16: 575-576. 1971.

A test established that cumulative hatch from cysts of the sugarbeet nematode is proportional to the log of the concentration of sugarbeet-root diffusate. Data also indicated that diffusate can be diluted to as much as 10 percent of its original concentration without significantly affecting its hatching activity. Consequently, with collection techniques used at this laboratory, concentration of hatch factor is not considered to be of critical importance to the standardization of hatching tests. The data demonstrate that host-plant diffusates of the sugarbeet nematode and the golden nematode of potato, while highly specific, show the same mathematical relationship between concentration and effect. This suggests that while their direct primary influences may differ, they may ultimately affect the same physiological process essential to hatching in these nematode species.

STEELE, A. E. Development of Heterodera schachtii on large rooted crop plants and the significance of root debris as substratum for increasing field infestations. J. Nematology 4: 250-256. 1972.

Heterodera schachtii developed to maturity and reproduced on the lateral roots of defoliated sugarbeet which were buried to a depth of 2.5 cm in sterilized soil and inoculated with cysts. Nematodes did not develop on detached lateral roots or on roots of young defoliated beets which did not have a large tap root. The storage roots of large rooted plants were sliced, placed in small jars, inoculated with cysts, covered with moist granulated agar or soil and incubated at 24°C 12-62 days. The sugarbeet nematode developed in root slices of sugarbeet, red table beet, icicle and globe radish, turnip and rutabaga. Only a few males developed on slices of potato tubers. Neither males nor females developed on root slices of carrot, salsify or parsnip. H. schachtii also developed on the cut surfaces of growing sugarbeet and radish.

STEELE, ARNOLD E. The effects of hot water treatments on survival of Heterodera schachtii Schmidt, 1871. (Accepted for publication by J. Nematology)

Heterodera schachtii cysts were treated in a water bath at constant temperatures ranging from 45 C - 62.5 C for time intervals ranging from 1 sec. to 28 hrs. Treated and untreated cysts were incubated 8 weeks in sugarbeet root diffusate at 24 C to initiate hatching and emergence of surviving larvae. Within the temperature range of 49 C - 54 C, the minimum lethal temperature was proportional to the log time of treatment. No larvae emerged from cysts exposed 10 seconds to 60 C. Although treatment of cysts 8 hours at 45 C significantly reduced emergence, increasing the treatment period to 28 hours did not completely suppress emergence.

STEELE, A. E. Evaluation of cyst selection as a means of reducing variation in sugarbeet nematode inocula. (Accepted for publication by J. Am. Soc. Sugar Beet Technol.)

A study was undertaken to determine if selection and storage of cysts at low temperatures effectively increases hatch potential. Hatching was greater for brown cysts than for the precystic females. Significantly greater numbers of hatched but not emerged larvae were found within "full" cysts than were found within "partially evacuated" cysts. In addition, significantly greater numbers of larvae emerged from "full" than "partially evacuated" cysts treated with either tap water or diffusate. Significantly fewer larvae hatched from loose eggs than from eggs which remained clumped after removal from cysts.

Hatching was increased by the use of diffusate in place of tap water with the increase being much greater for cysts stored at 24 C than 5 C.

Minimum and maximum numbers of larvae emerged from individual cysts were 1 and 656 larvae, respectively. The mean number of larvae emerged per cyst amounted to 255. Statistical analysis of the data revealed

that under a similar set of conditions, the mean would fall between 216 and 294 with a probability of 95 percent. The prediction of the population mean to within 5 percent of its actual value would require the utilization of 20 hand-picked cysts. At termination of the test, 11 cysts contained only eggs, 20 cysts contained only larvae, 174 cysts contained eggs and larvae, and 200 cysts were empty.

WHITNEY, E. D. and D. L. DONEY. The effects of soil types, inoculum levels, fertilizers, and water regimes on the development of Heterodera schachtii on selected lines of sugarbeet. (Approved by ARS for publication in J. Am. Soc. Sugar Beet Technol.)

Of five variables studied (soil type, inoculum level, watering regime, soil fertility, and nitrogen source), soil type and inoculum levels had the largest effect on the plant-to-plant variation in number of nematode cysts per plant. High proportions of sand increased inoculum efficiency and reduced variation in number of nematode larvae per plant. A low inoculum level of 0.4 larvae per g of soil reduced the variation in number of nematode cysts per g of soil after 4 months of reproduction on sugarbeet. Normal fertility reduced nematode reproduction but had no effect on plant-to-plant variation in number of nematode cysts. Low fertility tended to increase the effect of the nematode by increasing nematode reproduction and decreasing yield of sugarbeet. Source of nitrogen and watering regime had no effect on population buildup or variation in the number of cysts per plant.

ZIELKE, R. C. and G. J. HOGABOAM. Powered auger aids in planting mother beets. J. Am. Soc. Sugar Beet Technol. 16: 605-606. 1971.

Transplanting sugarbeet mother roots into seed increase plots can be a laborious job, especially when holes are dug manually with a spade or shovel. By using a small, powered, post-hole auger, the manual labor involved can be considerably reduced.

ZINK, F. W. and JAMES E. DUFFUS. Association of beet western yellows and lettuce mosaic viruses with internal rib necrosis of lettuce. Phytopathology 62: 1141-1144. 1972.

The internal rib necrosis (IRN) disease of Lactuca sativa L. 'Climax' that caused considerable damage in the Imperial Valley of California in 1969 was associated with two viruses prevalent in the area. Both beet western yellows virus (BWYV) and lettuce mosaic virus (LMV) were recovered from Imperial Valley lettuce cultivar Climax severely affected with IRN. The disorder was not reproduced in IRN-susceptible cultivars Climax and Vanguard by infection with BWYV. Infection with LMV produced IRN symptoms in a relatively low percentage of Climax plants, but none in Vanguard. The incidence of IRN was higher in both Climax and Vanguard when infected with the combination BWYV + LMV. A synergistic effect on the growth of Climax and Vanguard was observed when both viruses were present. The

IRN-resistant cultivars Great Lakes 118 and Calmar did not exhibit a synergistic response to the combination of the viruses. The genetic relationship of IRN-susceptible cultivars and the etiology of the disease on the basis of the combination of BWYV + LMV are discussed.

ZINK, F. W., JAMES E. DUFFUS, and K. A. KIMBLE. Relationship of a non-lethal reaction to a virulent isolate of lettuce mosaic virus and turnip mosaic susceptibility in lettuce. (Accepted for publication by J. Am. Soc. Hort. Sci.)

A mosaic disease of *Lactuca sativa* L. is described and the causal agent identified as a new virulent isolate of lettuce mosaic virus (LMV). The reservoir of infection was bristly oxtongue, *Picris echioides* L. *Lactuca sativa* L. cvs. Gallega, Calmar, Imperial 410, and Bibb systemically infected with virulent LMV did not transmit the virus through the seed. A survey of *L. sativa* cultivars indicated that the non-lethal reaction to the virulent isolate is restricted in the crisphead type to cultivars that are turnip mosaic virus (TuMV)-susceptible and downy mildew-resistant. A similar relationship was found in *L. serriola* lines. The non-lethal reaction is conferred by dominant complementary genes. 'Gallega' reported to be resistant to common LMV was found to be susceptible to systemic infection by the virulent LMV isolate.

SUGARBEET RESEARCH

1972 Report

Section B

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SUMMARY OF ACCOMPLISHMENTS, 1972

BOLTING RESISTANCE OF US H9 AND US H10 HYBRIDS--Results of 1970 and 1971 comparative bolting tests between US H9 and US H10 hybrids were inconclusive. Even though C17, the pollen parent of US H10, was consistently superior to C13, the pollen parent of US H9, this superiority was not always evident in the hybrids. In 1972 a group of commercial seed increases of US H9 and US H10 hybrids were evaluated for bolting resistance in a November 18 planting at Salinas. The 1972 season was favorable for the induction of bolting and on September 5 bolting averaged 13.3% for the entire test (page B10). Six 1971 seed increases of the US H10 hybrids were superior to two 1969 increases of the US H9 hybrids. Increases of the US H10 hybrids made in 1969 proved more bolting susceptible than 1971 increases and were similar in resistance to the 1969 increases of US H9. The results indicate that the bolting behavior of a seed lot may be affected by environmental conditions during the growing season as well as by heredity. Additional studies are planned to determine the effects of the environment on bolting.

In the 1972 test no differences were observed in root yield and sucrose percentage among the various seed lots of the US H9 and US H10 hybrids. J. S. McFarlane, I. O. Skoyen, R. T. Lewellen.

DIPLOID-TRIPLOID COMPARISONS--Additional comparisons were made between hybrids that utilized the diploid C13 and tetraploid C17 lines as pollen parents (page B18). There were no significant differences for sugar yield, root yield, or sucrose percentage between the corresponding diploid and triploid hybrids. A triploid hybrid (Monohil) from Sweden produced a significantly higher sucrose percentage than did most California-developed diploids and triploids. It was inferior in both root yield and sugar yield. A triploid from England was similar to the California hybrids in sugar percentage but inferior in both root yield and sugar yield. J. S. McFarlane, I. O. Skoyen, R. T. Lewellen.

YELLOWS RESISTANCE--Lines and hybrids derived or partially derived from the virus yellows breeding program were evaluated for performance, yellows resistance, and bolting resistance at Salinas, Brawley, and in sugar company tests throughout California. The results of these tests are presented in tabular form in this section. In tests 6 (page B19) and 7 (page B21), yellows selected self-sterile lines and 3-way hybrids were evaluated under yellows inoculated and noninoculated conditions. A combination of BYV-7 and BWYV-C71 was used. In test 6, significant interactions occurred for sugar yield and beet yield. In test 7, significant interactions also occurred for percent sucrose, percent bolting, and percent root rot. In test 6, yellows infection caused sugar yield losses from 16% for 117H45 to 39% for US H7A. Most of the hybrids showed losses that were not significantly different from the mean. This narrow range is probably caused by the use of pollinators, e.g., 813(C17), Y04, and Y01, with nearly equal

yellows resistance. In test 7, the mean sugar yield loss is nearly the same as in test 6, but there is a wider range of losses. This wider dispersion of yellows resistance-susceptibility probably accounts for the increased number of factors showing a significant interaction. In this test, sugar yield losses varied from 13.8% for Y104B to 43.6% for 868 (US 75). For tests 6 and 7, the means for percent bolting and percent root rot were over twice as great in the noninoculated treatment as in the inoculated treatment. Although overall these means were low, they demonstrated that within similar material (1) bolting increases as growth rate increases and (2) for the type of root rot occurring in these tests, the number of rotted roots increases as growth rate increases. The root rot was primarily of the recently identified Erwinia vascular necrosis and rot type. This relationship supports the hypothesis that rate of growth influences the chance of infection (due in part to larger and more numerous natural wounds in the faster growing beets). R. T. Lewellen, I. O. Skoyen, J. S. McFarlane.

YIELD LOSS PER INTERVAL OF YELLOWS INFECTION--To determine the relationship between potential loss and the time of virus yellows infection, two hybrids (US H7A and US H10B) and two open-pollinated lines (868 and 813) differing in yellows resistance were inoculated with a combination of BYV-7 and BWYV-C71 at 5 week intervals starting April 26 and ending August 10. The results of this test (test 8, page B23) showed that early infection caused significantly greater yield reductions than later infections. Significant variety by date of inoculation (infection) interactions occurred for sugar yield, beet yield, percent sucrose, and impurity index. Whereas, yellows resistant line 813 (C17) showed less than 1% loss in sugar yield per week of infection when compared to a noninoculated check, susceptible 868 (US 75) showed greater than 2% loss per week. Moderately resistant US H10B showed slightly greater than 1% loss per week of infection, whereas susceptible US H7A showed about 2% reduction per week. R. T. Lewellen, I. O. Skoyen, J. S. McFarlane.

VARIETY X YELLOWING VIRUSES--Beet varieties with yellows resistance derived from several sources and susceptible checks were inoculated with BYV-7, BWYV-C71, and a combination of BYV and BWYV and compared to noninoculated checks (test 10, page B25). Significant virus by variety interactions occurred for sugar yield, beet yield, percent sucrose, sodium concentration, and impurity index. These interactions indicated that some of the varieties were responding differently to the virus treatments. Sugar yield losses due to BYV infection ranged from 16.0% for Y803 to 52.9% for US H20. Sugar yield losses due to BWYV infection ranged from 0% (-2.5%) for US H10B to 15.4% for US H20. Lines or hybrids that showed lower losses to BYV also generally showed lower losses to BWYV and vice versa. The BYV-BWYV and BYV treatments caused about equal losses, and it was not shown that the losses due to BYV and BWYV were additive. BYV infection caused significant decreases in sugar yield, beet yield, and amino-N and sodium concentrations, and a significant increase in potassium concentration. BWYV infection caused significant decreases in sugar yield, beet yield, and percent sucrose and significant increases in sodium and potassium concentrations. US H20, which was developed in areas essentially free of virus yellows, in general shows the greatest effects of yellows infection. R. T. Lewellen, I. O. Skoyen, J. S. McFarlane.

BEET WESTERN YELLOWS VIRUS ISOLATES--In most of the tests and selection plots in which beets have been inoculated with BWYV or BYV-BWYV, a combination of BWYV isolates has been used. To test for the occurrence of more severe isolates than the combination presently being used (C71) and to test for possible variety by isolate interactions, a test composed of five varieties and inoculated with four BWYV isolates was grown in 1972 (test 11, page B27). BWYV-C71 caused a significant reduction in beet yield and gross sugar yield (11.3%). It was more severe than BWYV-B12 but slightly less severe than BWYV-B16. The mean varietal losses for gross sugar yield for BWYV-C71, -B12, and -B16 varied from 7.2% for 813 (C17) to 13.8% for Y803. A significant variety by isolate interaction did not occur. These results suggested that more severe isolates of BWYV than the one now being used in the yellows breeding program occur. Also, within the limits given by these varieties and isolates, the susceptible or resistant reaction of a variety is not specific to a particular isolate. Tests will be continued with additional varieties and isolates to identify severe BWYV isolates for use in the breeding and evaluation program and to determine if variety by isolate interactions do occur. R. T. Lewellen, J. E. Duffus, I. O. Skoyen.

ALTERNARIA AND BWYV INFECTION--Beets infected with BWYV are thought to be predisposed to infection by the fungus Alternaria. Alternaria infection may be partially responsible for the losses attributed to BWYV infection. To test this relationship, the hybrid US H7A was inoculated with four isolates of BWYV. Natural infection by Alternaria was controlled in half the plots by spraying with Captan at about 10 day intervals. The results of this test are inconclusive because little Alternaria infection occurred under either fungicide treatment (test 12, page B28) and there was no significant difference in yield performance between these two treatments. R. T. Lewellen, E. D. Whitney, J. E. Duffus, I. O. Skoyen.

VULGARIS-PROCUMBENS HYBRIDS--Dr. Savitsky examined 1,408 plants derived from B_4 and B_5 vulgaris-procumbens trisomics for nematode resistance and selected 169 resistant plants. Only one plant had 18 chromosomes. Dr. Read tested 2,895 plants derived from 19 chromosome B_2 vulgaris x procumbens and found 389 resistant plants. Of these, only four had 18 chromosomes and two had 18 chromosomes plus a fragment. Cytological studies reveal a low probability of obtaining a transfer of resistance by crossing over. Dr. Savitsky has transferred the B. procumbens chromosome to the B_6 generation and has selected 98 nematode resistant B_6 trisomics. Radiation studies are underway to induce a transfer of gene or genes for resistance from the B. procumbens chromosome to a B. vulgaris chromosome. Dr. Read has produced F_1 hybrids between B. vulgaris and B. companulata and is investigating the feasibility of transferring resistance from the companulata species. H. Savitsky, J. C. Read.

VULGARIS-COROLLINAE HYBRIDS--Resistance to the highly virulent 66-10 strain of curly top virus has been transferred to the B_5 generation of the vulgaris-corolliflora hybrid. Most resistant plants had 19 or more

chromosomes, but four plants were found with 18 chromosomes. Hybrids previously designated as vulgaris x macrorhiza are really vulgaris x trigyna. Curly top resistance and excellent vigor were transmitted from the vulgaris x trigyna hybrid to the B_1 generation. B_2 progenies are currently being evaluated for curly top resistance. H. Savitsky, J. S. McFarlane.

CHARACTERIZATION OF THE BEET CURLY TOP VIRUS--A series of intricate techniques involving density-gradient electrophoresis, virus assay by feeding insects on preparations through membranes, and an immunological technique, infectivity neutralization based on feeding insects on virus-antiserum reactants, has resulted in the characterization of the beet curly top virus.

The curly top viruses are known to occur in arid areas of the United States, South America, and Mediterranean Eurasia, but the geographical and ecological extent of their individual distribution is not known. These viruses resemble each other closely in symptoms, but the relationships with certain hosts and with the insects that transmit them are so specific and so different in the different areas as to raise questions as to their true relationships.

Plant and insect quarantines prevent direct comparison of the different curly top entities by transmission tests, but these studies indicate that curly top virus is immunogenic and may be tested by one of the most specific of all virus-antibody reactions--neutralization. These studies open the door to the possibility of a systematic study of the geographic distribution and interrelationships of the curly top viruses, which cause serious disease losses in several major world food crops. J. E. Duffus.

BACTERIAL ROOT ROT STUDIES--Field test of three hybrids, S301 H8, US H9A, US H10A, and of C-413, the topcross parent of the two US hybrids, showed an increase in percentage bacterial rot and a reduction in yield of C-413 by the bacterium (Erwinia species). The data suggest the increased susceptibility of C-413 is transmitted to the US hybrids.

Greenhouse studies showed bacterial infection to occur only in injured inoculated plants. An inoculation technique has been developed based on this observation. Tests of C-413 and the parental variety, US 75, showed the yellows resistant selection to be more susceptible than the parent. Variation in resistance occurs in both lines suggesting the possibility of selecting for bacterial rot resistance.

Quality of beets is reduced by a reduction in sucrose inversely proportional to the percentage rot and by an increase in amino nitrogen in some tests. Quality of beets grown in the Lost Hills area of California is further reduced by high sodium content of the beets. E. D. Whitney.

BEET YELLOWS VIRUS X RHIZOCTONIA STUDIES--Tests of beet yellows virus infected sugarbeet plants inoculated with *Rhizoctonia solani* showed the effect of the two on killing of plants to be additive. E. D. Whitney.

EFFECT OF ROTATION, SOIL FUMIGATION, AND FERTILIZER--The 1972 test was the final year of a three-year study on the effects of rotation, soil fumigation, and fertilizer levels on yield and purity of two sugarbeet varieties. Results showed fourth year beets had significantly lower root yields than either third-year or first-year beets. Gross sugar and percent sucrose showed no differences. Fumigation increased root yield and depressed percent sucrose significantly. The greatest increase in yield was with the first increment of fertilizer (78 lbs. nitrogen) without affecting percent sucrose. Fumigation increased root yield approximately the same as the first increment of fertilizer. The high nitrogen level, 264 lbs./A, reduced percent sucrose significantly. US H9B was superior to US H7A in yield, the same response as in 1970 and 1971. I. O. Skoyen, E. D. Whitney.

RESULTS OF 1972 NEMATICIDE TESTS--In separate studies, nematicides were tested for control of field populations of *Heterodera schachtii* on sugarbeet. Only 3, 4, or 6 lb/A Temik 10G significantly increased growth of sugarbeet by thinning time, and control was still evident 3 months after treatment. Four lb/A of Vidate 10G or 4 or 6 lb/A of Nemacur 15G also gave good control. Mocap at 4 or 6 lb/A stunted beets and failed to control the sugarbeet nematode. In three separate studies, nematicides were tested for lethal effects to embryonated larvae of *H. schachtii*. Only cysts treated with 100-1000 ppm Nemacur or 100 ppm Aldicarb sulfone reduced larval hatches. Prophos, Aldicarb, Aldicarb sulfoxide, Vidate or PP156 in concentrations of 100-1000 ppm had no effect on embryonated larvae. In vitro treatment of newly hatched larvae of *H. schachtii* with 5-100 ppm Aldicarb or Aldicarb sulfoxide significantly reduced the numbers of larvae on sugarbeet. Aldicarb sulfone had little or no nematicidal effect. A. E. Steele.

VARIETY TRIALS, SALINAS, CALIFORNIA, 1971-72

Location: USDA Agricultural Research Station

Soil type: Sandy Loam (Chualar series).

Previous crops: Vetch cover crop, 1971; fallow, 1970; barley, 1969.

Fertilizer used: The 1971-72 yield trial field received a ton per acre (/A) agricultural lime (85% $CaCO_3$) broadcast with disc incorporation to about 6" depth. Tests 1 through 4 (bolting evaluation trials) were seeded November 18-19, 1971. Preplant: 750 lbs/A 0:10:5 was broadcast and chiseled in before listing; 80 lbs/A actual N, as ammonium sulfate. Sidedressing: 75 lbs/A actual N, as ammonium sulfate, on March 17, 1972 and 67 lbs/A actual N, as liquid N, applied through sprinkler irrigation system on June 19, 1972.

Tests 5 (2n vs. 3n trial) and 6 and 7 (yellows inoculated vs. non-inoculated variety yield trials) were seeded January 12-14, 1972. Preplant: 750 lbs/A 0:10:5 was broadcast and chiseled in before listing; 90 lbs/A actual N, as ammonium sulfate. Sidedressing: Test 5, 80 lbs/A actual N, as ammonium sulfate, on March 23. Tests 6 and 7, 78 lbs/A actual N on April 12. Tests 5, 6, and 7, 67 lbs/A actual N, as liquid N, applied through sprinkler irrigation system on June 14-16.

Test 8 (virus yellows loss per interval of infection) was seeded February 17, 1972. Preplant: 750 lbs/A 0:10:5 was broadcast and chiseled in before listing; 80 lbs/A actual N, as ammonium sulfate. Sidedressing: 78 lbs/A actual N April 12, and 67 lbs/A actual N, as liquid N, applied through sprinkler irrigation system on June 14.

Tests 9 (yellows inoculated open-pollination progeny test), 10 (varieties x yellows viruses), 11 (varieties x BWYV isolates), and 12 (BWYV isolates x fungicide treatments) were seeded April 7-10, 1972. Preplant: 600 lbs/A 0:10:5 was broadcast and chiseled in before listing. 85 lbs/A actual N, as ammonium sulfate. Sidedressing: 67 lbs/A actual N, as liquid N, applied through sprinkler irrigation system June 14-16.

Thinning dates: Tests 1, 2, 3, and 4: January 31, 1972.
Tests 5, 6, and 7: February 24-26, 1972.
Test 8: March 17, 1972.
Tests 9, 10, 11, and 12: May 9-10, 1972.

Inoculation dates and yellows viruses used:

Tests 6 and 7: April 25-26 with combination of BYV-BWYV.
Test 8: date 1, April 26; date 2, June 5; date 3, July 7; date 4, August 10, all with combination of BYV-BWYV; and noninoculated check.
Test 9: June 5 with combination of BYV-BWYV.
Test 10: June 5 with a combination of BYV-BWYV; June 6 with BYV and BWYV.
Tests 11 and 12: June 6 with BWYV-C71, BWYV-3, BWYV-B12, and BWYV-B16.

Harvest dates:

Tests 1, 2, 3, and 4: September 12-15, 1972.
Test 5: September 19-20, 1972.
Test 6: replications 1 through 4, September 20-21, and replications 6 through 10, September 25-26, 1972.
Test 7: September 26-29, 1972.
Test 8: October 3-4, 1972.
Test 9: October 10-11, 1972.
Test 10: October 24-26, 1972.
Tests 11 and 12: October 4-5, 1972.

Irrigation: By sprinkler system as required at 10-14 day intervals.

Diseases and insects: Virus yellows infection was light during 1972 and the spread of yellows was controlled with spray applications of Meta Systox R until late in the season. The various tests were sprayed twice with Meta Systox R (2 pints/A) for control of aphid and leafminer, once or twice with Diazinon, AG-500 ($1\frac{1}{2}$ pints/A) for control of leafminer and once with Lannate (one lb/A) for control of aphid, worms, and leafminer. These applications were made between March 15 and August 12, 1972.

Experimental design:

Test 1: 10 entries in one-row plots with 5 replications, plots 53' long.
Test 2: 26 entries in one-row plots with 5 replications, plots 53' long.
Test 3: 84 entries in one-row plots with 4 replications, plots 32' long.
Test 4: 87 entries in one-row plots with 2 replications, plots 32' long.
Test 5: 10 entries in two-row plots with 8 replications, plots 53' long. Tests 1 through 5 were randomized block designs.
Tests 6, 7, 8, 10, 11, and 12: 22, 28, 4, 10, 5, and 2 entries, respectively, in one-row plots with 9, 10, 8, 12, 8, and 4 replications, respectively, and with plots 53', 53', 25' 7", 32', 25', and 25' long, respectively. The above tests were split-block designs with each replication being divided into 2, 2, 5, 4, 5, and 5 virus treatments, respectively.

Test 9: 60 entries in one-row plots with 6 replications, plots 27' long with randomized block design.

Sugar analysis: Determined from two samples per plot of approximately ten roots each at the sugar analytical laboratory, U.S. Agricultural Research Station, Salinas, California.

Remarks: Reliability should be good for all of the Salinas tests. Except for one isolated area of poor soil which necessitated deleting from the analyses data from two replications (9 and 10) in test 5 and one replication (5) in test 6, the field plot was quite uniform. Because natural and secondary spread of virus yellows was low until late in the season and virus inoculation caused essentially 100% infection, the comparisons of varieties within and between virus treatments and the effects of different virus treatments within varieties should be meaningful.

The assistance of Dr. Bruce Mackey, Biometrical Services staff, Western Region, ARS-USDA, Berkeley, California, in the analysis of these data is gratefully acknowledged.

TEST 1. PERFORMANCE OF COMMERCIAL SEED INCREASES OF US H9 AND US H10, SALINAS, CALIFORNIA, 1971-1972

5 replications
1 row plots, 53 ft. long

Planted: November 18, 1971
Harvested: September 12, 1972

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	7/5 Bolting Percent[1/]	8/7 Bolting Percent	9/5 Bolting Percent	Root Rot Percent	Beets/ 100' Number
US H10B	F69-813H8	12,620	42.39	14.9	11.1^{d}	19.9^{c}	24.5^{c}	0.3	160
US H10B	WC No. 1211	12,610	41.82	15.1	1.5^{a}	4.4^{a}	8.0^{a}	0.2	171
US H10B	WC No. 1006	12,260	41.29	14.9	2.2^{a}	6.2^{a}	9.9^{a}	0.2	157
US H10B	WC No. 1120	12,110	40.54	15.0	3.4^{ab}	6.4^{a}	9.5^{a}	0.4	174
US H10A	F69-813H4	12,350	41.29	15.0	8.0^{cd}	17.3^{bc}	21.5^{bc}	1.0	151
US H10A	WC No. 1043	12,330	41.49	14.9	1.9^{a}	4.3^{a}	6.6^{a}	0.3	149
US H10A	WC No. 1231	12,220	41.20	14.9	1.8^{a}	4.4^{a}	5.5^{a}	0.7	164
US H10A	WC No. 1230	11,600	39.97	14.6	3.6^{ab}	7.9^{a}	9.6^{a}	0.4	165
US H9B	WC No. 9034	12,570	42.56	14.8	9.9^{cd}	16.2^{bc}	21.0^{bc}	0.3	159
US H9A	WC No. 9162	11,420	37.93	15.1	7.0^{bc}	14.5^{b}	17.1^{b}	0.0	162
Mean		12,210	41.05	14.9	5.0	10.2	13.3	0.4	161
LSD (.05)		NS	NS	NS	3.73	4.67	5.96	--	NS
C.V. (%)		8.52	8.93	2.69	57.62	35.82	34.91	--	12.97
F value		NS	NS	NS	7.82**	14.16**	11.32**	--	NS

**Exceeds the 1% point of significance (F=2.94).

1/Means with a letter in common are not significantly different at the 5% level.

TEST 2. BOLTING EVALUATION TRIAL, SALINAS, CALIFORNIA, 1971-72

5 replications
1 row plots, 53 ft. long

Planted: November 18, 1971
Harvested: September 13, 1972

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	7/5 Bolting	8/7 Bolting	9/5 Bolting	Root Rot	Beets/ 100'
		Pounds	Tons	Percent	Percent	Percent	Percent	Percent	Number
USH10A	Seed Lot No's 1230, 1043, 1231	12,950	43.94	14.7	4.8	10.3	13.7	0.7	160
Y004H8	546H3 x Y904A	12,870	44.50	14.4	4.2	8.7	12.6	0.2	143
117H63	8551H1 x 813	12,470	44.26	14.1	4.0	8.6	11.2	0.3	129
117H60	0534-3H52 x 813	12,450	43.26	14.5	5.6	12.9	16.2	0.5	101
USH10B	Seed Lot No's 1006, 1120, 1211	12,450	43.68	14.3	2.0	6.0	6.7	0.3	153
117H62	8536H1 x 813	12,430	43.70	14.2	5.6	14.8	19.9	1.4	131
117H45	(705H25 x 7718) x 813	12,340	42.02	14.7	3.0	10.4	12.7	0.6	130
664H4	569H3 x 64 (US H7)	12,300	43.01	14.4	5.6	10.3	12.7	0.3	156
813H8	546H3 x 713A	12,270	43.25	14.2	2.9	5.9	8.5	0.2	142
U913H4	USH9A	12,070	42.03	14.5	6.5	18.1	20.3	0.8	145
117H69	0705H5 x 813	12,040	41.82	14.4	8.5	17.8	22.9	2.9	135
117H8	546H3 x 813	11,990	41.20	14.5	1.5	7.3	11.0	1.5	103
117H73	0724H5 x 813	11,920	41.07	14.5	5.2	9.7	12.9	1.5	103
U913H8	USH9B	11,850	40.89	14.6	8.4	12.1	15.1	0.3	141
F69-813H4	569H3 x C813	11,780	41.35	14.2	9.6	17.0	21.7	0.5	145
117H59	0536-35H53 x 813	11,700	42.27	13.8	11.9	21.1	29.5	0.3	125
F69-813H8	546H3 x C813	11,660	40.50	14.4	8.3	16.2	20.5	0.2	146
664H8	546H3 x 64 (US H7A)	11,630	40.26	14.4	9.5	17.3	21.0	0.0	149
117H70	0705H52 x 813	11,510	40.11	14.3	8.0	16.0	22.2	1.9	117
Y101H69	0705H5 x Y001A,B	11,500	39.57	14.5	16.5	25.1	33.3	0.4	125
Y101H8	546H3 x Y001A,B	11,400	38.89	14.7	18.0	25.0	32.7	0.3	100
117H52	8522H1 x 813	11,310	39.81	14.2	4.5	9.4	13.5	2.2	91
1770H8	546H3 x 0770,1A	10,770	37.40	14.5	4.1	10.2	10.7	0.3	127
117H75	(9705H0A x 9724) x 813	10,740	36.78	14.6	5.9	13.6	15.4	1.1	72
1773H8	546H3 x 0773A	10,260	35.64	14.4	6.8	11.8	16.4	0.5	86
1774H8	546H3 x 0774A	9,520	32.36	14.7	10.2	16.8	18.9	0.0	100
Mean		11,780	40.91	14.4	7.0	13.5	17.4	--	125
LSD (.05)		1,180	4.10	NS	4.38	6.13	7.08	--	21.81
Coefficient of Variation		8.01	7.98	4.52	50.15	36.06	32.42	--	13.89
F value		3.48**	3.90**	NS	6.58**	5.83**	7.50**	--	9.35**

** Exceeds the 1% point of significance (F = 1.98)

TEST 3. BOLTING EVALUATION TEST, SALINAS, CALIFORNIA, 1971-72

4 replications
1 row plots, 32 ft. long

Planted: November 19, 1971
Harvested: September 13, 1972

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	7/5 Bolting	8/7 Bolting	9/5 Bolting	Root Rot	Beets/ 100'
		Pounds	Tons	Percent	Percent	Percent	Percent	Percent	Number
3-way Hybrids									
Y003H8	F68-546H3 x Y803	13,360	45.33	14.8	2.4	4.3	12.4	3.8	133
117H46	7718H32mm x 813	13,230	47.43	14.0	2.3	8.0	12.5	2.9	137
004H8	F68-546H3 x 944	13,170	45.06	14.7	6.4	14.0	16.4	2.3	134
Y101H63	8551H1 x Y001A,B	12,920	46.92	13.8	15.0	23.2	31.2	2.8	113
117H16	F68-546H5 x 813	12,880	45.18	14.3	9.3	21.6	23.0	3.2	120
Y001H8	F68-546H3 x Y801	12,000	41.04	14.7	10.2	19.2	25.5	3.6	127
117H17	F69-551H5 x 813	11,960	45.57	13.1	5.9	12.9	18.2	5.5	111
117H74	0724H52 x 813	11,960	41.91	14.3	3.3	9.0	15.9	4.4	116
117H76	0724H55 x 813	11,940	41.82	14.3	8.7	18.3	20.7	4.8	87
110H8	546H3 x 910	11,530	39.69	14.5	5.0	12.7	18.5	5.6	89
Y101H16	F68-546H5 x Y001A,B	11,070	37.53	14.9	22.6	32.5	37.4	3.6	110
117H71	0705H56 x 813	11,060	41.55	13.4	10.4	16.5	27.8	2.8	114
Y101H73	0724H5 x Y001A,B	11,050	37.53	14.8	13.2	20.1	22.9	2.8	111
110H69	0705H5 x 910	10,990	38.85	14.1	9.4	21.8	23.2	6.4	109
Y101H70	0705H52 x Y001A,B	10,590	37.95	14.0	7.0	23.9	30.5	3.4	119
Y101H75	0724H54 x Y001A,B	10,330	35.76	14.5	14.2	34.1	36.5	4.9	95
Open-pollinated Lines									
868	Inc. F57-68 (US 75)	11,430	42.27	13.5	7.8	11.8	16.2	2.4	141
Y004	Inc. Y904A	11,210	38.34	14.7	5.6	8.7	10.0	3.4	123
Bush Mono A	From Ellerton in 1971	11,150	40.86	13.8	12.0	16.8	24.6	4.3	135
123-3	Inc. 023-3	11,090	39.84	13.9	4.5	8.7	10.6	3.9	109
123-1	Inc. 023-1	11,000	41.07	13.5	5.3	13.0	13.7	8.0	103
Y001	Inc. Y801	10,990	38.61	14.3	18.4	25.5	34.3	2.7	121
044	Inc. 944	10,910	40.41	13.7	8.3	22.2	24.0	4.3	117
Y104B	YRS Y904A,B (G.S.)	10,820	39.90	13.6	16.4	30.2	41.4	3.3	139
F66-64	Inc. 264	10,800	40.05	13.5	4.4	9.0	16.2	3.6	138
F70-13	Inc. F66-413 (0268)	10,700	37.44	14.3	12.3	17.8	22.4	3.6	136
Y101	Inc. Y001A,B	10,700	36.15	15.0	26.9	37.3	46.8	4.8	104
Y004B	Inc. Y904B	10,680	37.26	14.5	4.1	11.9	14.9	4.2	132

TEST 3. BOLTING EVALUATION TEST, SALINAS, CALIFORNIA, 1971-72 continued

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	7/5 Bolting	8/7 Bolting	9/5 Bolting	Root Rot	Beets/ 100'
		Pounds	Tons	Percent	Percent	Percent	Percent	Percent	Number
F71-17	Inc. F70-17	10,620	38.04	14.0	2.9	7.1	9.9	6.5	134
Y127	Inc. 013 (BRS 13 soft)	10,600	35.61	15.1	2.5	5.3	9.2	3.1	130
110	Inc. 910	10,550	35.49	14.9	5.3	8.5	14.7	5.2	117
117	Inc. 813	10,470	37.95	13.9	10.9	13.2	18.3	8.2	88
Y126	YRS 959 (US 56/2)	10,340	34.86	15.0	19.7	39.4	45.4	2.8	140
Y104A	YRS Y904A,B (%S)	10,330	35.43	14.7	8.7	15.0	20.7	6.3	130
Y003	Inc. Y803	10,280	34.47	15.0	0.7	7.9	10.8	3.0	128
F70-17	Inc. C813	10,150	35.85	14.2	3.3	9.0	11.2	5.5	134
813 Ore.	Inc. 713A	9,990	36.00	13.9	2.6	7.2	9.2	7.1	126
Y123	YRS 915 (US 15)	9,910	34.05	14.7	6.9	19.1	22.8	3.4	144
014	Inc. 814	9,820	35.70	14.0	10.0	19.2	28.4	5.3	133
813 Spence	Inc. 713A	9,820	35.07	14.0	3.2	9.7	15.9	5.3	120
Y116	YRS Y916	9,720	36.03	13.4	32.8	43.6	54.7	5.3	124
123-2	Inc. 023-2	9,430	34.98	13.8	3.4	10.7	13.6	3.9	133
Y128	Inc. 813-2 (mm 813)	9,350	32.10	14.7	0.9	0.9	3.5	5.6	110
Y125	YRS 632,733 (US 33)	6,220	24.30	12.8	82.1	86.8	91.3	2.7	143
Y124	YRS 628 (US 22/3)	4,170	16.77	12.5	80.3	84.6	92.4	4.5	141
F_1 Hybrids									
1718H77	0724H56 x 9718	12,260	43.74	14.0	4.9	8.0	16.6	3.2	126
7718H31	6705H25 x 7718	11,990	44.13	13.6	9.5	18.7	23.5	5.9	141
1705H72	9718HO x 9705	11,140	41.58	13.4	4.2	18.4	25.1	9.5	102
1724H72	9718HO x 9724	10,950	40.17	13.7	11.8	22.8	26.6	4.7	125
1718H54	0705HOA x 9718	10,750	37.74	14.2	6.4	11.5	19.7	5.1	122
0724H5	F68-564HO x 9724	10,710	35.82	14.9	11.9	20.7	25.7	2.4	131
0705H52	8522H1 x 9705	9,990	34.80	14.4	10.5	14.7	22.4	4.2	132
0705H5	F68-564HO x 9705	9,830	35.34	13.9	20.4	35.2	40.2	4.4	125
1705H63	8551H1 x 9705	9,700	35.76	13.5	14.3	21.3	27.7	3.3	120
1705H77	0724H56 x 9705	9,620	34.08	14.1	13.8	23.5	27.0	7.7	88
1718H52	8522H1 x 9718	9,400	34.98	13.4	10.5	12.7	14.0	4.0	123
1718H63	8551H1 x 9718	9,180	33.96	13.5	3.3	10.1	12.3	2.3	140
1705H62	8536H1 x 9705	8,800	31.95	13.8	16.1	31.7	37.3	4.8	116

TEST 3. BOLTING EVALUATION TEST, SALINAS, CALIFORNIA, 1971-72 continued

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	7/5 Bolting	8/7 Bolting	9/5 Bolting	Root Rot	Beets/ 100'
		Pounds	Tons	Percent	Percent	Percent	Percent	Percent	Number
1565H52	8522H1 x 9564	8,290	30.87	13.5	25.6	32.7	38.9	5.9	126
1724H54	0705HOA x 9724	8,280	29.97	13.8	17.7	26.9	30.4	3.8	108
1718H5	F68-564HO x 9718	8,210	29.19	14.1	18.4	26.6	32.3	5.0	111
1536H61	0522-25H53 x 8536	7,050	27.36	13.0	35.6	43.0	53.1	3.5	102
1565H62	8536H1 x 9564	7,030	25.08	14.1	18.2	32.7	38.4	3.5	113
Self-fertile Lines									
1774Ma	0774Maa x 0774A	12,100	43.29	14.0	17.5	23.2	32.7	3.3	119
1773a	0773aa x 0773A	11,340	40.68	14.0	10.8	14.0	15.5	3.4	116
1773H54	0705HO x 0773A	10,780	37.92	14.3	7.2	14.2	20.3	3.2	132
1797Ma	0797Maa x 0797A	10,510	37.98	13.8	13.4	22.6	25.7	2.3	138
1793H5	F68-564HO x 0793A	10,350	35.01	14.8	20.1	32.3	37.2	4.2	117
1770Ma	0770,1Maa x 0770,1A	10,290	37.20	13.8	7.1	13.1	13.6	2.4	135
1798Ma	0798Maa x 0798A	10,130	36.24	14.0	5.9	10.0	16.6	3.6	128
1797H5	F68-564HO x 0797A	10,100	36.72	13.9	9.3	17.4	21.9	3.9	120
1798H5	F68-564HO x 0798A	9,790	35.28	13.9	16.3	25.8	34.2	7.8	113
1792Ma	0792Maa x 0792A	9,610	35.43	13.5	17.0	29.2	32.7	4.1	134
1794Ma	0794Maa x 0794A	9,600	33.75	14.2	4.1	9.8	11.6	6.4	139
1793Ma	0793Maa x 0793A	9,440	32.82	14.4	9.8	15.4	17.1	4.2	133
1792H5	F68-564HO x 0792A	9,020	31.47	14.4	14.5	22.7	27.8	4.3	109
1770MA	Inc. 0770,1A	8,970	33.09	13.6	4.1	9.4	11.2	2.6	121
1773A	Inc. 0773A	8,740	31.80	13.9	7.3	11.7	13.3	2.9	109
1774MA	Inc. 0774A	7,840	27.78	14.1	12.9	21.7	29.3	2.9	113
1797MA	Inc. 0797A	7,810	28.26	13.8	20.1	27.3	35.6	3.7	103
1798MA	Inc. 0798A	7,390	27.72	13.5	11.7	17.5	20.7	4.2	109
1794MA	Inc. 0794A	6,940	24.84	13.9	4.0	7.9	11.2	3.4	138
1792MA	Inc. 0792A	6,890	24.90	13.8	19.7	27.1	28.3	4.7	113
1793MA	Inc. 0793A	6,570	23.55	14.0	8.7	13.4	14.3	4.9	106
Mean		10,130	36.15	14.0	12.4	20.1	25.0	4.3	121
Coefficient of Variation (%)		13.2	14.07	5.1	48.2	39.0	37.6	60.0	14.1
LSD (.05)		1,849	7.05	1.0	8.3	10.9	13.0	3.6	23.7
F value		6.3**	5.06**	2.1**	18.6**	12.6**	10.1**	1.4*	2.7*

* and ** Exceeds the 5% (F = 1.32) and 1% (F = 1.47) points of significance, respectively.

TEST 4. BOLTING EVALUATION TRIAL, SALINAS, CALIFORNIA, 1971-72

2 replications
1 row plots, 32 ft. long

Planted: November 19, 1971
Harvested: September 12, 1972

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	7/5 Bolting	8/7 Bolting	9/5 Bolting	Root Rot	Beets/ 100'
		Pounds	Tons	Percent	Percent	Percent	Percent	Percent	Number
8536-97C2	Inc S_3(F57-85 x 1561-16-7C1)	4,340	15.12	14.4	3.3	4.5	7.4	1.7	113
8551	Inc 5550 Type O Selection	2,920	10.38	14.1	0.0	11.8	11.8	0.0	67
1536-21	Inc 8536-21C2	3,510	13.20	13.2	56.8	68.9	74.0	5.6	73
1536HO	8536H1 x 8536	6,160	24.24	12.7	35.0	48.4	53.8	1.5	117
1536-35	Inc 8536-35C2	2,980	12.06	12.4	41.8	52.1	52.1	5.6	92
1522-25	Inc 8522-25,8522-25A	1,850	7.68	12.7	0.0	0.0	0.0	8.0	86
1502	Inc 0502	6,660	25.50	13.1	49.8	53.7	64.8	0.0	106
1502HO	0502HO x 0502	6,570	23.76	13.8	29.6	51.1	58.7	7.6	102
1565	Inc 9564	6,970	23.16	15.1	20.0	28.5	39.8	2.3	141
1565HO	F68-564HO x 9564	5,280	18.24	14.5	28.8	46.0	52.7	0.0	94
8852	Inc CTRS S_3(1561-16-7 x 2646-32-5)	4,840	16.32	14.8	44.5	64.3	68.8	1.4	109
023-1	BRS 413	11,080	39.24	14.2	3.6	16.7	30.0	0.0	136
023-2	BRS 413	10,310	36.36	14.2	4.5	11.4	14.9	0.0	136
023-3	BRS 413	9,320	33.84	13.9	0.0	6.6	11.6	3.4	95
Y106	F_3B_1(mm x Y01)mm	8,170	27.36	15.0	25.8	34.4	47.3	1.7	108
Y107	F_3B_1(mm x Y04)mm	9,880	36.36	13.6	14.6	21.1	27.4	3.5	111
Y108	F_3B_1(mm x 13)mm	7,980	29.28	13.6	6.0	20.9	30.3	0.0	84
Y110	F_3B_1(mm x 10)mm	10,180	36.48	14.0	13.2	21.4	27.2	0.0	111
Y111	F_3B_1(mm x Y03)mm	8,300	27.36	15.2	1.5	1.5	1.5	0.0	98
1230	0792aa x 700mm series	9,530	32.52	14.7	17.3	27.3	33.4	0.0	127
1231	0793aa x 700mm series	10,180	33.96	15.0	14.1	17.3	24.1	0.0	109
1232	0797aa x 700mm series	10,710	37.74	14.2	3.8	13.8	21.6	0.0	125
F71-705	Inc C0705 (9705)	3,830	15.42	12.9	32.1	33.8	37.3	3.5	114
F71-705HO	C0705HO x C0705	4,820	17.52	13.8	28.2	35.9	39.7	0.0	39
1705	Inc 9705	1,500	5.52	13.8	41.7	41.7	41.7	8.4	28
1705HO	0705HOA x 9705	3,570	12.84	13.5	27.1	33.3	35.4	0.0	50
0705	Inc 9705	3,830	15.66	12.8	21.0	29.9	37.4	1.7	108
0705HOA	9705HOA x 9705	6,060	23.76	13.1	10.9	24.2	32.6	0.0	134
1707	YRS 9707	3,530	11.58	15.2	17.3	17.3	17.3	0.0	88
1708	YRS S_1(M,aa x mm, S^f, YR)	7,400	24.42	15.5	0.0	3.5	5.9	1.2	136

TEST 4. BOLTING EVALUATION TRIAL, SALINAS, CALIFORNIA, 1971-72 continued

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	7/5 Bolting	8/7 Bolting	9/5 Bolting	Root Rot	Beets/ 100'
		Pounds	Tons	Percent	Percent	Percent	Percent	Percent	Number
1709	YRS S_1(mmaa x M,S^f,YR)	6,320	21.36	15.0	8.4	18.6	21.2	2.6	113
1710	YRS S_1(YR,M,aa x mm,S^f,CTR)	5,770	19.14	15.1	4.8	8.0	11.2	3.2	98
1713	YRS S_1(YR,M,aa x mm,S^f,CTR)	6,920	23.64	14.8	18.2	24.6	29.9	0.0	128
1714	YRS 9714	7,160	27.30	13.1	25.8	25.8	43.8	0.0	80
0716	Inc 9716-11mm	5,950	24.48	12.5	1.6	2.7	5.3	1.6	120
7716	Inc 6716	7,620	27.72	13.8	0.0	0.0	1.2	3.7	130
7716HO	6716HO x 6716	11,220	41.40	13.6	0.0	1.2	4.7	1.2	150
7718	Inc 6718	6,040	21.60	14.1	13.3	26.9	30.3	2.2	127
1718	Inc 9718	6,380	21.96	14.7	2.5	5.2	10.3	0.0	123
1718HO	9718HO x 9718	9,220	32.76	14.2	2.4	6.0	9.5	0.0	123
1722	YRS 9722	5,580	20.10	14.0	14.9	21.4	33.2	1.1	145
0724	Inc 9724	4,940	16.92	14.8	12.2	18.3	20.3	0.0	77
1724	Inc 9724	3,010	10.80	14.1	12.6	22.9	30.8	10.6	45
1724HO	0724H56 x 9724	7,980	28.26	14.2	3.8	8.5	14.2	1.9	98
1729	YRS S_1(M,aa x M,YR)	9,860	35.88	13.8	11.7	16.4	19.9	0.0	133
1730	YRS S_1(13 x mm,S^f,CTR)	9,390	33.84	13.9	15.3	24.5	27.9	0.0	133
1731	YRS S_1(YO4 x mm,S^f,CTR)	8,820	33.48	13.2	14.3	21.4	23.8	0.0	131
1733	YRS S_1(YO1,10,44 x mm,S^f,CTR)	7,640	27.30	14.0	9.9	22.6	25.4	1.5	111
1736	YRS S_1(M,aa x mm,S^f,CTR)	6,990	23.52	14.9	6.6	9.5	12.3	0.0	117
1737	YRS S_1(M,aa x mm,S^f,CTR)	7,630	26.88	14.3	4.2	7.5	10.8	1.1	139
1755C1	S_1(mmaa x M,YR,S^f)	7,030	27.00	13.2	16.1	33.2	41.3	0.0	95
9759	YRS 6759	5,860	21.66	13.8	0.0	0.0	0.0	0.0	142
9760	Inc 7760C2	6,440	23.40	13.7	44.4	61.1	70.7	0.0	123
1761-1C1	S_2(13 x 7522)mm	5,760	22.14	13.0	3.9	8.9	13.9	14.5	117
1761-2C1	S_2(13 x 7534)mm	5,850	20.40	14.5	4.3	4.3	10.0	0.0	108
1761-3C1	S_2(13 x 8536)mm	7,050	26.64	13.3	29.0	40.1	43.7	0.0	127
1761-4C1	S_2(13 x 7601)mm	3,640	13.56	13.4	37.1	40.9	53.0	0.0	86
1761-5C1	S_2(13 x 6532)mm	6,670	26.34	12.6	22.0	35.1	41.2	2.0	116
1761-6AC1	S_2(13 or YO4 x 7564 or 6563)mm	6,490	23.88	13.6	12.4	12.4	14.2	0.0	103
1762-1C1	S_2(YO4 x 7522)mm	8,760	32.88	13.4	12.7	16.6	19.5	5.0	130
1762-1LC1	S_2(YO4 x 7522)mm late	7,040	29.70	12.1	0.0	0.0	1.4	0.0	123

TEST 4. BOLTING EVALUATION TRIAL, SALINAS, CALIFORNIA, 1971-72 continued

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	7/5 Bolting	8/7 Bolting	9/5 Bolting	Root Rot	Beets/ 100'
		Pounds	Tons	Percent	Percent	Percent	Percent	Percent	Number
1762-2C1	S_2(Y04 x 7534)mm	5,950	22.56	13.2	34.8	35.9	38.6	0.0	119
1762-3C1	S_2(Y04 x 7536)mm	6,700	26.82	12.5	54.5	64.3	76.5	3.5	141
1762-5C1	S_2(Y04 x 7564)mm	8,530	30.54	14.0	24.3	34.7	42.1	0.0	141
1762-7C1	S_2(Y04 x 7823)mm	7,390	25.92	14.4	17.1	23.4	31.9	0.0	122
1763-1,2,3,4C1	S_2(Y01 x 7564,7823,7832,8699)mm	8,050	28.68	14.2	16.0	21.0	24.9	2.3	117
1763-5C1	S_2(10 x 6563)mm	8,580	32.34	13.2	30.6	36.4	47.6	0.0	138
1763-6C1	S_2(44 x 7823)mm	6,600	22.92	14.4	5.9	5.9	5.9	0.0	106
1763-8C1	S_2(44 x 8677)mm	6,280	21.84	14.4	9.2	17.7	22.9	0.0	128
1765C1	S_2(S^f,CTR,mm,rr x 7760R)mm	5,830	21.18	13.8	27.4	37.1	43.8	0.0	108
1766C1	S_2(S^f,CTR,mm,rr x 7757R)mm	6,910	26.28	13.2	32.4	36.5	41.0	4.1	111
1767C1	S_2(S^f,CTR,mm,rr x 7734,54R)mm	6,040	23.22	13.0	25.0	34.4	38.5	0.0	113
1768C1	S_2(S^f,CTR,mm,rr x 7704,16R)mm	8,740	32.40	13.6	21.9	28.7	31.0	0.0	136
0769	Inc S_1(6522 x 6705)	5,790	20.88	13.9	25.3	37.1	45.2	0.0	136
0770MA	Inc S_1(7711aa x 735,714,705)	8,750	32.64	13.4	12.8	15.6	21.0	0.0	113
0770Ma	9770Maa x 9770A	10,700	39.84	13.4	4.1	13.9	18.3	0.0	119
0771MA	Inc S_1(7711aa x 724, 718,...)	8,850	34.08	13.0	0.0	3.8	11.1	0.0	120
0771Ma	9771,2Maa x 9711,2A	12,180	45.00	13.6	2.1	6.4	13.4	0.0	141
0773A	Inc S_1(7711,2aa x 754,760,716...)	10,270	37.44	13.7	8.4	15.4	16.7	0.0	113
0773a	9773,7aa x 9773,7A	12,780	47.28	13.5	4.9	17.3	24.7	1.3	127
0774MA	Inc S_1(7712aa x 705,724,563...)	7,740	28.86	13.4	14.7	20.8	25.6	0.0	131
0774Ma	9774,5,6Maa x 9774,5,6A	10,940	39.00	14.1	17.8	30.5	31.7	0.0	123
1795MA	Inc S_1(Maa x 6823,7832,6864...)	7,130	24.96	14.3	0.0	5.4	8.1	1.5	116
1795Ma	0795Maa x 0795A	9,920	33.90	14.6	5.6	9.1	11.4	0.0	136
1796A	Inc S_1(Maa x 13,21,10,Y04)	7,360	26.22	14.1	5.3	5.3	5.3	3.2	109
1796a	0796aa x 0796A	11,630	42.18	13.8	5.8	10.3	16.0	0.0	136
6512	Inc 5512-1 (NB6)	8,730	34.08	12.8	0.0	1.0	1.0	0.0	136
Mean		7,190	26.14	13.8	15.7	22.5	27.5	--	113
LSD (.05)		2,330	8.21	1.48	15.08	18.38	20.82	--	41.62
Coefficient of Variation (%)		16.31	15.81	5.39	48.46	41.19	38.16	--	18.48
F value		8.32**	8.76**	1.97**	6.82**	6.43**	6.11**	--	2.61**

TEST 5. DIPLOID-TRIPLOID COMPARISON TEST, SALINAS, CALIFORNIA, 1972

8 replications
2 row plots, 53 ft. long

Planted: January 12, 1972
Harvested: September 19, 1972

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolting	Root Rot	Beets/ 100'
		Pounds	Tons	Percent	Percent	Percent	Number
117H8	546H3 x 713A	13,320	44.65	14.9	0.8	2.6	140
113TH8	546H3 x 713T	13,390	46.12	14.5	0.8	2.0	132
117H52	8522H1 x 713A	13,320	46.15	14.4	0.4	2.2	141
113TH52	8522H1 x 713T	13,070	46.16	14.2	1.1	2.3	135
117H63	8551H1 x 713A	13,140	46.29	14.2	0.7	1.0	142
113TH63	8551H1 x 713T	12,980	45.11	14.4	0.9	1.6	136
117H62	8536H1 x 713A	13,130	45.08	14.6	0.8	1.4	149
113TH62	8536H1 x 713T	13,060	45.63	14.3	1.6	2.6	133
L26984	Triploid from Sweden	12,610	41.15	15.3	6.7	0.7	146
B4M/VT-70	Triploid from England	11,340	39.03	14.6	1.3	1.0	133
Mean		12,940	44.54	14.5	1.5	1.7	139
LSD (.05)		645	2.35	0.48	0.83	1.04	7.52
Coefficient of Variation (%)		4.99	5.28	3.29	54.31	60.16	5.43
F value		6.97**	8.76**	4.36**	40.61**	3.60**	4.73**

** Exceeds the 1% point of significance (F = 2.70)

TEST 6. VARIETY X VIRUS YELLOWS TEST, SALINAS, CALIFORNIA, 1972

9 replications
2 virus treatments
1 row plots, 53 ft. long

Planted: January 13, 1972
Inoculated: April 25, 1972
Harvested: September 20, 1972

		Sugar Yield (lb/A)			Beet Yield (Tons/A)		
Variety	Description	Check	Inoc.	% Loss	Check	Inoc.	% Loss
Y004H8	546H3 x Y904A	13,150	10,540	19.5	44.32	36.30	17.4
F69-813H8	546H3 x C813 (C17)	13,100	9,690	25.7	44.44	34.49	22.0
117H8	546H3 x 813 (C17)	13,010	10,040	22.5	43.55	35.03	19.4
Y101H8	546H3 x Y001A,B	12,900	9,540	26.0	43.24	33.23	22.9
F69-813H4	569H3 x C813 (C17)	12,890	9,240	28.2	43.14	32.74	24.1
117H45	7718H31 x 813	12,870	10,710	16.0	44.78	38.03	14.2
US H10A	WC No. 1231	12,840	9,380	26.8	43.13	33.51	22.2
813H8	546H3 x 713A	12,760	9,960	21.7	43.83	34.91	20.1
117H17	F69-551H5 x 813	12,750	9,080	27.8	44.12	33.13	23.9
U913H8	US H9B	12,610	8,830	29.4	43.54	31.86	26.3
117H52	8522H1 x 813	12,520	8,980	28.3	43.13	31.76	26.1
Y101H69	0705H5 x Y001A,B	12,440	8,860	28.4	41.16	31.38	23.5
US H10B	WC No. 1068	12,440	9,480	23.0	42.03	34.01	18.3
117H62	8536H1 x 813	12,410	8,830	28.9	42.67	31.89	25.3
664H8	546H3 x 64 (US H7A)	12,390	7,560	39.2	40.48	26.62	34.3
117H60	0534-3H52 x 813	12,280	9,200	25.0	41.88	32.48	22.1
117H69	0705H5 x 813	12,250	9,320	23.8	42.02	32.98	21.4
117TH52	8522H1 x 917T	12,220	8,760	28.3	41.60	31.09	24.9
117H59	0536-35H53 x 813	12,130	9,150	24.1	42.28	33.26	20.7
U913H4	US H9A	12,030	8,520	29.0	41.42	30.98	25.1
Y101H75	0724H54A x Y001A,B	11,690	9,090	21.6	39.08	32.24	16.9
117H75	0724H54A x 813	11,540	9,120	21.0	38.94	31.94	18.0
Mean		12,510	9,270	25.7	42.49	32.90	22.2
LSD (.05)		699	699	5.3	2.42	2.42	5.1
Coefficient of Variation (%)		7.5	7.5	22.2	7.7	7.7	24.8
F value		6.5**	6.5**	6.08**	6.43**	6.43**	5.28**

TEST 6. VARIETY X VIRUS YELLOWS TEST, SALINAS, CALIFORNIA, 1972 continued

9 replications
2 virus treatments
1 row plots, 53 ft. long

Planted: January 13, 1972
Inoculated: April 25, 1972
Harvested: September 20, 1972

Variety	Description	% Sucrose Check	% Sucrose Inoc.	% Sucrose % Loss	Beets/ 100' Number	Bolting Percent	Root Rot Percent
Y004H8	546H3 x Y904A	14.9	14.5	2.4	148	0.54	0.92
F69-813H8	546H3 x C813 (C17)	14.8	14.1	4.8	147	1.18	0.74
117H8	546H3 x 813 (C17)	15.0	14.4	4.0	144	0.14	0.68
Y101H8	546H3 x Y001A,B	15.0	14.4	3.9	127	2.94	0.71
F69-813H4	569H3 x C813 (C17)	15.0	14.1	5.4	148	1.12	1.13
117H45	7718H31 x 813	14.4	14.1	2.0	146	0.15	0.87
US H10A	WC No. 1231	14.9	14.0	5.8	152	0.66	0.42
813H8	546H3 x 713A	14.6	14.3	1.8	139	0.16	1.29
117H17	F69-551H5 x 813	14.5	13.7	5.1	139	0.43	0.53
U913H8	US H9B	14.5	13.9	4.2	145	0.33	0.29
117H52	8522H1 x 813	14.6	14.1	2.9	138	0.51	0.67
Y101H69	0705H5 x Y001A,B	15.1	14.2	6.3	139	2.03	1.03
US H10B	WC No. 1068	14.8	14.0	5.8	149	0.60	0.65
117H62	8536H1 x 813	14.6	13.9	4.6	148	0.21	0.53
664H8	546H3 x 64 (US H7A)	15.4	14.2	7.4	149	0.90	0.08
117H60	0534-3H52 x 813	14.8	14.2	3.6	138	0.53	1.06
117H69	0705H5 x 813	14.7	14.2	3.1	149	0.14	2.26
117TH52	8522H1 x 917T	14.8	14.1	4.4	146	0.15	1.39
117H59	0536-35H53 x 813	14.4	13.8	4.1	141	1.47	1.28
U913H4	US H9A	14.6	13.8	5.3	147	0.85	0.46
Y101H75	0724H54A x Y001A,B	15.0	14.1	5.7	134	1.34	0.72
117H75	0724H54A x 813	14.9	14.3	3.8	129	0.35	1.91
Mean		14.8	14.1	4.4	143	0.76	0.89
LSD (.05)		0.37	0.37	3.1	5.8	0.78	0.78
Coefficient of Variation (%)		3.2	3.2	76.9	6.2	157	134
F value		3.42**	3.42**	1.61*	10.1**	6.3**	3.3**

* and ** Exceeds the 5% and 1% points of significance, respectively.

Significant (5% level) interactions occurred for sugar yield and beet yield.

TEST 7. VARIETY X VIRUS YELLOWS TEST, SALINAS, CALIFORNIA, 1972

10 replications
2 virus treatments
1 row plots, 53 ft. long

Planted: January 14, 1972
Inoculated: April 25, 1972
Harvested: September 26, 1972

Variety	Description	Sugar Yield (lb/A) Check	Sugar Yield (lb/A) Inoc.	Sugar Yield (lb/A) % Loss	Beet Yield (Tons/A) Check	Beet Yield (Tons/A) Inoc.	Beet Yield (Tons/A) % Loss
Y003H8	546H3 x Y803	14,360	10,500	26.7	46.22	34.49	25.1
117H16	546H5 x 813	13,710	10,290	24.2	44.04	34.48	21.1
110H69	0705H5 x 910	13,450	9,470	29.4	43.82	32.15	26.5
Y104C	YRS Y904A,B	13,360	10,870	18.4	44.98	38.51	14.0
Y101H70	0705H52 x Y001A,B	13,320	9,240	30.0	42.74	31.04	26.7
Y101H16	546H5 x Y001A,B	13,220	9,510	27.4	42.23	31.36	25.1
110H8	546H3 x 910	13,160	9,450	27.8	42.53	31.51	25.7
Y104B	YRS Y904A,B (G.S.)	13,150	11,250	13.8	42.94	37.77	11.2
Y101	Inc. Y001A,B	12,990	9,880	23.5	42.01	33.21	20.5
Y101H73	0724H5 x Y001A,B	12,960	8,750	32.7	41.13	30.15	27.1
117H70	0705H52 x 813	12,960	10,030	22.1	42.87	33.61	21.2
Y001	Inc. Y801	12,680	9,270	26.3	40.41	31.31	21.7
117H73	0724H5 x 813	12,560	9,430	24.6	40.68	31.90	21.5
Y116	YRS Y916	12,550	9,190	26.6	40.96	31.06	24.0
Y104A	YRS Y904A,B (%S)	12,390	10,400	15.2	39.83	34.66	12.1
110	Inc. 910	12,360	9,650	21.5	39.56	32.21	18.1
Y004	Inc. Y904A	12,230	10,090	16.6	39.22	34.55	10.9
1773H8	546H3 x 0773A	12,230	8,730	28.0	39.78	29.52	25.4
117	Inc. 813 (C17)	11,930	9,160	22.6	39.66	31.09	20.9
F70-17	Inc. C813 (C17)	11,920	10,090	14.9	38.86	33.54	13.0
F71-17	Inc. F70-17	11,770	9,760	16.9	38.40	32.60	14.7
Y003	Inc. Y803	11,760	9,470	18.7	37.15	31.17	15.1
F70-413	Inc. C413	11,640	8,790	23.1	38.54	30.31	20.2
813 Ore.	Inc. 713A	11,440	9,390	17.5	36.81	31.14	14.9
Y127	Inc. 013/1	10,880	7,650	29.2	35.40	25.91	26.3
F66-64	Inc. 264	10,770	6,550	38.8	34.70	22.58	34.6
117T	Inc. 917T	10,440	7,500	27.5	35.48	26.01	26.0
868	Inc. F57-68 (US 75)	9,990	5,580	43.6	34.19	20.17	40.5
Mean		12,360	9,280	24.6	40.18	31.36	21.6
LSD (.05)		732	732	5.4	2.35	2.35	5.5
Coefficient of Variation (%)		8.8	8.8	25.2	9.3	9.3	29.0
F value		25.2**	25.2**	12.7**	19.8**	19.8**	12.3**

TEST 7. VARIETY X VIRUS YELLOWS TEST, SALINAS, CALIFORNIA, 1972 continued

10 replications
2 virus treatments
1 row plots, 53 ft. long

Planted: January 14, 1972
Inoculated: April 25, 1972
Harvested: September 26, 1972

Variety	Description	% Sucrose Check	% Sucrose Inoc.	% Loss	Beets/100' Number	Bolting Percent	Root Rot Percent
Y003H8	546H3 x Y803	15.6	15.3	2.1	150	0.31	0.01
117H16	546H5 x 813	15.6	15.0	4.0	147	0.31	0.46
110H69	0705H5 x 910	15.4	14.8	4.0	142	0.34	1.36
Y104C	YRS Y904A,B	14.9	14.2	4.9	146	1.94	1.47
Y101H70	0705H52 x Y001A,B	15.6	14.9	4.5	146	1.53	0.53
Y101H16	546H5 x Y001A,B	15.7	15.2	3.1	139	2.89	0.81
110H8	546H3 x 910	15.5	15.1	2.8	130	0.98	0.60
Y104B	YRS Y904A,B (G.S.)	15.4	14.9	2.9	144	0.40	0.86
Y101	Inc. Y001A,B	15.5	14.9	3.8	133	3.22	0.92
Y101H73	0724H5 x Y001A,B	15.8	14.6	7.6	145	1.50	0.30
117H70	0705H52 x 813	15.1	15.0	1.2	155	0.54	0.99
Y001	Inc. Y801	15.8	14.8	5.8	137	3.06	1.03
117H73	0724H5 x 813	15.5	14.8	4.1	152	0.05	0.77
Y116	YRS Y916	15.3	14.8	3.4	133	8.95	0.78
Y104A	YRS Y904A,B (%S)	15.6	15.0	3.5	143	0.98	1.28
110	Inc. 910	15.7	15.0	4.1	141	0.20	0.65
Y004	Inc. Y904A	15.6	14.6	6.3	145	0.44	1.57
1773H8	546H3 x 0773A	15.4	14.9	3.5	140	0.41	0.16
117	Inc. 813 (C17)	15.1	14.7	2.3	137	0.00	1.67
F70-17	Inc. C813 (C17)	15.4	15.1	2.0	152	0.06	1.92
F71-17	Inc. F70-17	15.4	15.0	2.4	145	0.13	1.91
Y003	Inc. Y803	15.9	15.2	4.1	136	0.14	0.43
F70-413	Inc. C413	15.1	14.6	3.8	142	0.24	1.03
813 Ore.	Inc. 713A	15.6	15.1	3.0	148	0.22	1.54
Y127	Inc. 013/1	15.4	14.8	3.8	134	0.07	1.23
F66-64	Inc. 264	15.5	14.5	6.2	151	0.30	0.39
117T	Inc. 917T	14.8	14.5	1.9	123	0.00	5.21
868	Inc. F57-68 (US 75)	14.6	13.9	5.2	143	0.13	0.26
Mean		15.4	14.8	3.8	142	1.05	1.08
LSD (.05)		0.36	0.36	2.9	6.31	0.75	0.60
Coefficient of Variation (%)		3.7	3.7	86.2	7.2	148.7	117.4
F value		5.0**	5.0**	2.0**	10.4**	27.2**	11.64**

** Exceeds the 1% point of significance

Significant (5% level) interactions occurred for sugar yield, beet yield, % sucrose, percent bolting, and percent root rot.

TEST 8. VIRUS YELLOWS LOSS PER INTERVAL OF INFECTION, SALINAS, CALIFORNIA, 1972

8 replications
5 dates of inoculation
1 row plots, 25 ft. 7 inches long

Planted: February 17, 1972
Harvested: October 3, 1972

Variety	Sugar Yield (lb/A) Check	8/10 1/	7/7	6/5	4/26	mean 2/	Sugar Yield Loss (%) 8/10	7/7	6/5	4/26	mean
US H10B	12,028	11,238	9,569	9,252	8,140	10,045a	6.57	20.44	23.08	32.32	20.60
US H7A	10,674	10,190	8,600	7,189	6,685	8,668c	4.53	19.43	32.65	37.37	23.50
813 (C17)	9,784	9,705	8,721	8,900	8,440	9,110b	0.81	10.86	9.04	13.74	8.61
868 (US 75)	8,623	8,248	6,254	5,315	4,050	6,498d	4.35	27.47	38.36	53.03	30.80
Mean	10,277a	9,845b	8,286c	7,664d	6,829e	8,580	4.20	19.37	25.43	33.55	20.64

Variety	Beet Yield (Tons/A) Check	8/10	7/7	6/5	4/26	mean	% Sucrose Check	8/10	7/7	6/5	4/26	mean
US H10B	38.56	36.28	32.68	30.38	26.56	32.89a	15.6	15.5	14.7	15.2	15.3	15.3ab
US H7A	34.44	33.36	30.20	24.50	21.64	28.83b	15.5	15.3	14.2	14.7	15.5	15.0b
813 (C17)	31.48	31.45	28.67	28.75	26.62	29.39b	15.5	15.4	15.2	15.5	15.9	15.5a
868 (US 75)	28.80	28.16	24.30	19.36	13.87	22.90c	15.0	14.7	12.9	13.7	14.6	14.2c
Mean	33.32a	32.31a	28.96b	25.75c	22.17d	28.50	15.4a	15.2a	14.2c	14.8b	15.3a	15.0

Variety	PPM Amino-N	PPM Na	PPM K	Impurity Index	Root Rot %	Beets/ 100'
US H10B	510a	311a	1499a	653a	0.26a	157a
US H7A	506a	470b	1612b	716b	0.17a	153a
813 (C17)	518a	289a	1613b	661a	1.31b	148ab
868 (US 75)	546a	665c	1643b	846c	0.26a	139b
Mean	520	434	1592	719	0.50	149

1/ Dates of inoculation with BYV-BWYV.

2/ Main effect means with a letter in common are not significantly different at the 5% level.

LSD (.05) values for sugar yield, beet yield, and % sucrose are 511 lb/A, 1.54 T/A, and 0.35%, respectively.

Significant (1% level) interactions occurred for sugar yield, beet yield, % sucrose, and impurity index.

TEST 9. OPEN POLLINATED PROGENY TEST
SALINAS, CALIFORNIA, 1972

6 replications
1 row plots, 27 ft. long

Planted: April 7, 1972
Inoculated: June 5, 1972
Harvested: October 10, 1972

Progeny No.	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot	Beets/ 100'	Progeny No.	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot	Beets/ 100'
	Pounds	Tons	Percent	Percent	Number		Pounds	Tons	Percent	Percent	Number
1773	5,090	18.37	13.8	0.82	134	1773-54	5,020	17.81	14.1	0.03	133
1773A	4,130	14.96	13.8	2.75	128	-55	5,000	17.88	14.0	0.50	135
1773H8	4,850	17.01	14.3	0.03	133	-17	4,960	17.85	13.9	1.87	132
1773H54	5,350	19.04	14.1	0.45	141	-37	4,950	17.43	14.3	1.33	132
1773-6	6,110	21.61	14.2	0.03	143	-43	4,940	17.64	14.0	0.45	130
-38	5,990	20.49	14.7	0.03	134	-3	4,900	17.67	13.9	0.03	122
-2	5,900	21.52	13.8	1.72	138	-13	4,890	16.80	14.6	0.03	120
-34	5,860	20.68	14.2	0.03	144	-29	4,870	18.02	13.5	0.48	141
-41	5,610	20.05	14.0	1.26	146	-16	4,860	17.46	13.9	2.19	125
-31	5,610	20.54	13.7	1.42	134	-7	4,770	17.92	13.3	1.94	130
-32	5,580	19.25	14.5	0.03	133	-36	4,760	16.59	14.4	1.44	134
-5	5,430	19.21	14.1	0.52	135	-12	4,730	16.83	14.0	0.47	122
-15	5,370	18.55	14.5	0.95	131	-46	4,680	17.01	13.7	0.03	137
-19	5,370	18.55	14.5	0.03	129	-20	4,610	16.22	14.2	0.61	112
-27	5,350	19.56	13.7	0.88	135	-51	4,510	17.29	13.1	2.38	139
-33	5,340	18.55	14.4	0.03	129	-28	4,490	16.57	13.5	0.48	129
-35	5,300	18.46	14.4	1.36	132	-50	4,450	15.28	14.6	0.03	113
-26	5,290	18.48	14.3	0.55	119	-42	4,430	16.06	13.8	1.47	125
-8	5,130	17.64	14.6	1.43	131	-22	4,410	16.71	13.3	0.03	128
-45	5,120	18.23	14.1	0.03	130	-9	4,360	16.34	13.5	6.99	127
-14	5,110	18.39	13.9	0.03	136	-10	4,350	15.56	14.0	2.69	116
-53	5,110	20.00	12.8	2.31	130	-23	4,180	16.03	13.1	0.86	143
-60	5,080	19.02	13.4	0.03	140	-24	4,040	15.35	13.2	1.07	125
-39	5,070	17.62	14.5	0.51	129	-1	2,800	10.17	13.8	0.55	117
-11	5,050	17.53	14.5	0.54	119	Mean	4,950	17.74	14.0	0.91	131
-58	5,040	19.00	13.3	0.60	130	LSD (.05)	572	2.02	0.92	1.81	12.71
-47	5,030	17.41	14.4	0.03	135	CV (%)	10.16	10.01	5.77	173.70	8.53
-18	5,030	17.78	14.2	0.50	133	F value	7.19**	6.59**	1.79**	3.28**	2.83**

** Exceeds the 1% point of significance (F = 1.32)

TEST 10. VARIETY X VIRUS TEST, SALINAS, CALIFORNIA, 1972

12 replications
4 virus treatments
1 row plots, 32 ft. long

Planted: April 7, 1972
Inoculated: June 5, 1972
Harvested: October 24, 1972

Variety	Sugar Yield (lb/A) Check	BYV-BWYV	BYV	BWYV	mean[1]	Sugar Yield Loss (%) BYV-BWYV	BYV	BWYV
Y101	8,368	6,542	6,466	8,246	7,405a	21.8	22.7	1.5
Y104A	8,285	7,176	6,788	8,014	7,566a	13.4	18.1	3.3
US H10B	8,152	6,116	6,199	8,359	7,207a	25.0	24.0	-2.5
Y803	8,135	6,787	6,837	7,819	7,394a	16.6	16.0	3.9
US H7A	7,630	4,633	5,017	7,113	6,098c	39.3	34.2	6.8
813 (C17)	7,176	5,873	5,873	7,082	6,501b	18.2	18.2	1.3
US H20	6,976	3,004	3,285	5,903	4,792de	56.9	52.9	15.4
F70-413	6,948	5,389	5,648	6,771	6,189bc	22.4	18.7	2.5
B4M/VT-70	6,866	3,802	3,726	6,045	5,110d	44.6	45.7	12.0
868 (US 75)	6,245	2,895	3,007	5,614	4,440e	53.6	51.8	10.1
Mean	7,478a	5,222c	5,285c	7,096b	6,270	30.2	29.3	5.5

Variety	Beet Yield (Tons/A) Check	BYV-BWYV	BYV	BWYV	mean	% Sucrose Check	BYV-BWYV	BYV	BWYV	mean
Y101	29.69	23.81	23.17	29.45	26.53a	14.1	13.7	14.0	13.9	13.9bcd
Y104A	28.78	25.06	23.44	28.46	26.44a	14.4	14.3	14.5	14.1	14.3b
US H10B	29.15	21.61	21.77	29.61	25.54ab	14.0	14.2	14.3	14.1	14.1bcd
Y803	27.01	23.06	23.12	25.70	24.73b	15.1	14.7	14.8	15.2	14.9a
US H7A	27.54	17.17	17.89	26.16	22.19c	13.9	13.5	14.0	13.6	13.7cd
813 (C17)	25.26	20.37	20.32	25.43	22.85c	14.2	14.4	14.4	13.9	14.2bc
US H20	25.49	12.15	12.91	22.51	18.27d	13.7	12.4	12.8	13.1	13.0e
F70-413	25.21	19.39	20.06	25.21	22.47c	13.8	13.9	14.1	13.4	13.8cd
B4M/VT-70	24.67	13.98	13.72	22.20	18.64d	13.9	13.6	13.6	13.6	13.7d
868 (US 75)	23.72	11.20	11.55	21.28	16.94e	13.2	13.0	13.0	13.2	13.1e
Mean	26.65a	18.78c	18.80c	25.60b	22.46	14.0	13.8	13.9	13.8	13.9

TEST 10. VARIETY X VIRUS TEST, SALINAS, CALIFORNIA, 1972 continued

Variety	PPM Amino-N Check	BYV-BWYV	BYV	BWYV	mean	PPM Na Check	BYV-BWYV	BYV	BWYV	mean
Y101	686	586	627	665	641bc	957	936	854	1,023	943de
Y104A	674	567	614	638	623ab	587	581	453	650	568ab
US H10B	630	559	591	702	620ab	623	446	428	600	524a
Y803	558	493	461	512	506a	703	800	741	686	732bc
US H7A	636	558	557	588	585ab	777	808	623	880	772cd
813 (C17)	630	608	551	614	601ab	612	417	457	657	536a
US H20	752	791	751	665	740c	835	1,102	963	1,023	981e
F70-413	708	663	578	629	645bc	634	507	471	744	589ab
B4M/VT-70	607	585	559	583	584ab	1,005	945	986	1,127	1,016e
868 (US 75)	656	668	731	680	684bc	989	886	893	1,017	946de
Mean	654b	608a	602a	628ab	623	772b	743b	687a	841c	761

Variety	PPM K Check	BYV-BWYV	BYV	BWYV	mean	Impurity Index	% Root Rot	Beets/ 100'
Y101	1,943	2,016	2,048	1,983	1,998e	1,065cde	1.4b	109d
Y104A	1,854	1,984	1,985	1,983	1,952e	921abc	1.2ab	118c
US H10B	1,655	1,737	1,726	1,639	1,689c	878ab	1.2ab	139a
Y803	1,464	1,534	1,557	1,543	1,524b	769a	0.6ab	113d
US H7A	1,701	1,771	1,769	1,749	1,748cd	949bcd	0.3a	134b
813 (C17)	1,754	1,845	1,873	1,823	1,824d	883ab	3.0c	122c
US H20	1,333	1,310	1,355	1,291	1,322a	1,105de	0.6ab	133b
F70-413	1,814	2,088	2,009	2,060	1,993e	987bcde	3.6c	111d
B4M/VT-70	1,728	1,883	1,773	1,686	1,767cd	1,025bcde	0.9ab	112d
868 (US 75)	1,707	1,791	1,790	1,867	1,789cd	1,135e	1.2ab	122c
Mean	1,695a	1,796b	1,789b	1,762b	1,761	972	1.4	121

1/ Main effect means with a letter in common are not significantly different at the 5% level.

LST (.05) values for sugar yield, beet yield, % sucrose, and sodium are 459 lb/A, 1.46 T/A, 0.36%, and 124 ppm, respectively.

Significant (1% level) interactions occurred for sugar yield, beet yield, % sucrose, ppm Na, and impurity index.

TEST 11. VARIETIES x BWYV ISOLATES, SALINAS, CALIFORNIA, 1972

8 replications
5 virus treatments
1 row plots, 25 ft. long

Planted: April 10, 1972
Inoculated: June 6, 1972
Harvested: October 4, 1972

Variety	Sugar Yield (lb/A)					
	Check	C71	3	B12	B16	Mean[1/]
US H10B	7,461	6,835	7,516	6,740	6,308	6,972a
Y803	6,754	5,763	6,805	5,962	5,732	6,203bc
US H7A	6,753	5,905	6,722	6,207	6,022	6,322b
813(C17)	6,073	5,595	6,461	5,878	5,432	5,888c
868(US 75)	5,550	4,811	5,518	4,924	4,764	5,114d
Mean	6,518a	5,782bc	6,604a	5,942b	5,651c	6,100

Variety	Sugar Yield Loss (%)				% Root	Beets/
	C71	B12	B16	Mean	Rot	100'
US H10B	8.39	9.66	15.45	11.17	2.4ab	142a
Y803	14.67	11.73	15.13	13.84	1.4a	121c
US H7A	12.56	8.09	10.82	10.49	0.8a	137a
813(C17)	7.87	3.21	10.55	7.21	3.3b	130b
868(US 75)	13.32	11.28	14.16	12.92	0.9a	126bc
Mean	11.29	8.84	13.30	11.13	1.8	131

Variety	Beet Yield (T/A)					
	Check	C71	3	B12	B16	Mean
US H10B	25.68	23.91	25.51	24.38	22.97	24.49a
Y803	21.68	18.59	21.77	19.50	18.51	20.01c
US H7A	24.06	21.61	23.78	22.52	21.76	22.75b
813(C17)	20.12	18.55	21.57	19.58	18.23	19.61c
868(US 75)	21.12	18.74	20.74	19.17	18.94	19.74c
Mean	22.53a	20.28c	22.67a	21.03b	20.08c	21.32

Variety	% Sucrose					
	Check	C71	3	B12	B16	Mean
US H10B	14.5	14.3	14.7	13.8	13.7	14.2c
Y803	15.6	15.6	15.6	15.3	15.5	15.5a
US H7A	14.0	13.5	14.1	13.8	13.8	13.8c
813(C17)	15.1	15.2	15.0	15.0	14.9	15.1b
868(US 75)	13.1	12.7	13.3	12.8	12.6	12.9d
Mean	14.5a	14.3ab	14.5a	14.1b	14.1b	14.3

1/ Main effect means with a letter in common are not significantly different at the 5% level.

No significant interactions occurred.

TEST 12. BWYV ISOLATES X FUNGICIDE TREATMENT,

SALINAS, CALIFORNIA, 1972

4 replications
5 virus x 2 fungicide treatments
1 row plots, 25 ft. long
Variety: US H7A

Planted: April 10, 1972
Inoculated: June 6, 1972
Harvested: October 4, 1972

BWYV Isolate	Sugar Yield (lb/A) 1 1/	2	mean 2/	Sugar Yield Loss (%)
Check	6291	6094	6192a	-
3	5957	6003	5980ab	3.4
B12	5920	5523	5721ab	7.6
B16	5758	5598	5678ab	8.3
C71	4922	5720	5321b	14.1
Mean	5769 NS	5788	5778	8.4

BWYV Isolate	Beet Yield (Tons/A) 1	2	mean	Beet Yield Loss (%)
Check	22.62	22.02	22.32a	-
3	21.87	20.40	21.14ab	5.3
B12	19.58	19.28	19.43bc	12.9
B16	20.71	20.10	20.40abc	8.6
C71	17.70	19.88	18.79c	15.8
Mean	20.49 NS	20.34	20.42	10.7

BWYV Isolate	% Sucrose 1	2	mean	% Root Rot	Beets/ 100'
Check	13.9	13.9	13.9a	0.80a	127a
3	13.7	14.6	14.1a	0.03a	120a
B12	15.1	14.3	14.7a	0.03a	129a
B16	14.0	14.1	14.0a	0.42a	129a
C71	13.9	14.3	14.1a	0.42a	121a
Mean	14.1 NS	14.2	14.2	0.34	125

1/ 1 = Check, 2 = Fungicide. Fungicide used was Captan applied following irrigation at about 10 day intervals.

2/ Main effect means with a letter in common are not significantly different at the 5% level.

VARIETY TRIALS, BRAWLEY, CALIFORNIA, 1971-72

Location:	U.S. Department of Agriculture, Imperial Valley Conservation Research Center.
Soil type:	Holtville silty clay loam.
Previous crops:	Sugarbeets, 1968-69; barley, 1969-70 and 1970-71.
Fertilizers used:	Preplant: 200 lbs. per acre (/A) 11:48:0, broadcast before listing. Sidedressing: 150 lbs./A actual N, as Urea, on October 7, 1971. 80 lbs./A, actual N, as ammonium nitrate, on January 15, 1972.
Planting date:	September 17-18, 1971.
Thinning date:	October 5, 1971.
Harvest dates:	Early harvests - Tests 1 and 2, April 26-27, 1972. Late harvest - Test 3, June 20, 1972.
Irrigations:	Early harvests - eight by furrow. Late harvest - ten by furrow.

Diseases and insects: Yellows infection was light during 1972. Curly top infection was minor. Infestations of desert flea beetle, striped cucumber beetle, cricket, beet armyworm, cabbage looper and cutworm were controlled during the growing season with applications of 6-3 ethyl-methyl parathion, Lannate, phosdrin and Sevin bait. Aphid buildups were controlled with applications of 10% Thimet granules.

Experimental design: Tests 1 and 3 had 22 and 15 entries, respectively, in randomized block design and were sown in two-row plots. The tests had 10 replications each. Test 2 had 10 entries in a 10 x 10 latin square design, seeded in single-row plots. Plots were 40' long with rows spaced 30" apart.

Sugar analysis: From two ten-beet samples per plot for all trials by Holly Sugar Corporation, Brawley, California.

Remarks: Test designed and data analyzed by the U.S. Agricultural Research Station, Salinas, California. After stands were established, the plot was under supervision of J. Robertson and A. J. MacKenzie, United States Department of Agriculture, Imperial Valley Conservation Research Center, Brawley, California.

VARIETY TEST, BRAWLEY, CALIFORNIA, 1972

(10 replications of each variety)
(Two-row plots)

Planted: September 14, 1971
Harvested: April 26, 1972

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Percent	Harvest Count Number
117H60	0534-3H52 x 813	8,710	28.37	15.4	0.0	134
117H52	8522H1 x 813	8,600	28.07	15.3	0.0	141
Y904H45	7718H31 x Y804	8,270	27.17	15.2	0.3	142
F69-813H8	US H10B (1969 prod.)	8,130	26.15	15.6	0.0	148
117TH52	8522H1 x 917T	8,100	27.00	15.0	0.0	142
117H45	7718H31 x 813	8,070	26.87	15.0	0.0	132
117H8	US H10B (1971 prod.)	8,050	25.69	15.7	0.0	137
113TH8	546H3 x 813T	8,030	26.32	15.3	0.3	128
U913H8	US H9B	8,020	25.95	15.5	0.2	145
U913H4	US H9A	8,000	26.04	15.4	0.1	146
113TH62	8536H1 x 813T	7,980	27.07	14.8	0.0	126
117H59	0536-35H53 x 813	7,970	25.87	15.4	0.0	129
Y004H8	546H3 x Y904	7,970	25.70	15.5	0.0	147
F69-813H4	US H10A	7,940	25.70	15.5	0.2	152
Y101H8	546H3 x Y001	7,900	25.16	15.7	0.0	124
117H69	0705H5 x 813	7,890	25.54	15.5	0.0	135
Y101H69	0705H5 x Y001	7,870	25.58	15.4	0.5	134
117H62	8536H1 x 813	7,780	26.46	14.7	0.0	137
664H8	US H7A	7,670	24.72	15.5	0.2	150
117H75	0724H54 x 813	7,360	23.88	15.4	0.0	107
1773H8	546H3 x 0773	7,130	23.37	15.3	0.0	120
Y101H75	0724H54 x Y001	6,860	22.36	15.4	0.3	123
Mean		7,920	25.87	15.3	0.09	Beets
LSD (.05)		360	1.16	0.42	---	per
Coefficient of Variation (%)		5.15	5.10	3.11	---	100'
F value		10.06**	11.44**	2.86**	---	row

**Exceeds the 1% point of significance (F=1.97).

VARIETY TEST, BRAWLEY, CALIFORNIA, 1972

(10 x 10 Latin Square)
(Single-row plots)

Planted: September 15, 1971
Harvested: April 27, 1972

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Percent	Harvest Count Number
U913H8	US H9B	8,770	31.51	13.9	0.0	155
Y101	Inc. Y001	8,220	28.90	14.2	5.3	141
116	Early maturity sel. 813	7,680	27.28	14.1	0.0	148
F70-13(413)	Inc. 5 YRS, US 75	7,400	27.51	13.5	0.9	152
118	Salt sel. 813	7,310	25.64	14.3	0.6	150
Y104	YRS Y904	7,220	25.94	13.9	6.3	149
014	Early maturity sel. 413	6,870	25.25	13.6	1.4	149
F70-17	Inc. 8 YRS, 2 SS US 75	6,680	23.57	14.2	0.3	142
1773A	Inc. 0773	6,390	23.02	13.9	0.7	140
117T	Tetra 813	6,150	22.83	13.5	0.0	126
Mean		7,270	26.14	13.9	1.6	Beets
LSD (.05)		468	1.62	0.4	---	per
Coefficient of Variation (%)		7.22	6.94	3.2	---	100'
F value		23.76**	22.96**	4.69**	---	row

**Exceeds the 1% point of significance (F=2.67).

VARIETY TEST, BRAWLEY, CALIFORNIA, 1972

(10 replications of each variety)
(Two-row plots)

Planted: September 15, 1971
Harvested: June 20, 1972

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Percent	Root Rot Percent	Harvest Count Number
U913H8	US H9B	14,990	45.49	16.5	0.2	1.1	150
113TH8	546H3 x 813T	14,960	46.27	16.2	0.0	1.3	129
F69-813H8	US H10B	14,860	44.82	16.6	0.3	0.8	148
117H52	8522H1 x 813	14,690	44.63	16.5	0.0	0.9	141
117H8	US H10B	14,650	44.65	16.4	0.0	1.3	139
117H45	7718H31 x 813	14,460	45.03	16.1	0.4	1.6	137
113TH62	8536H1 x 813T	14,350	45.45	15.8	0.1	1.3	124
Y101H8	546H3 x Y001	14,280	43.92	16.3	0.7	1.4	128
117H62	8536H1 x 813	14,280	43.40	16.5	0.0	1.1	141
U913H4	US H9A	14,200	43.62	16.3	0.3	0.9	148
117TH52	8522H1 x 917T	14,160	44.70	15.9	0.2	1.6	139
Y004H8	546H3 x Y904A	14,150	43.49	16.3	0.5	1.5	147
F69-813H4	US H10A	14,090	43.50	16.2	0.3	0.8	146
117H75	0724H54A x 813	13,250	40.70	16.3	0.3	0.7	119
664H8	US H7A	13,110	40.21	16.3	0.3	1.4	145
Mean		14,300	43.99	16.3	0.2	1.2	Beets
LSD (.05)		674	2.09	NS	---	---	per
Coefficient of Variation (%)		5.32	5.37	3.25	---	---	100'
F value		5.10**	4.96**	1.75	---	---	row

**Exceeds the 1% point of significance (F=2.23).

VARIETY TEST, IMPERIAL VALLEY, CALIFORNIA, 1972
(Results Extracted from Test of 20 Varieties)

14 replications, 1 row plots,
50 feet long, 32 inches between rows

Holly Sugar Corporation
Planted: September 14, 1971
Harvested: June 27, 1972

Variety	Description	Extractable Sugar/Acre Pounds	Extractable Sugar/Ton Pounds	Gross Sugar/Acre Pounds	Beets/ Acre Tons	Sucrose Percent	Bolters Percent
US H10A	569H3 x C17	4,132	238.0	5,425	17.4	15.62	0.0
US H9B	546H3 x C13	4,102	235.8	5,410	17.4	15.55	1.0
US H9A	569H3 x C13	3,913	238.1	5,145	16.5	15.63	0.0
117H45	(6705H25 x 7718) x C17	3,883	219.9	5,276	17.7	14.94	0.0
117H60	0534-3H52 x C17	3,836	226.8	5,147	16.9	15.20	0.0
117H69	(546H0 x 9705) x C17	3,826	229.5	5,100	16.7	15.29	1.0
Y101H8	546H3 x Y001	3,727	241.4	4,872	15.5	15.75	1.0
Y101H63	(564H0 x 8551) x Y001	3,715	229.5	4,958	16.2	15.30	1.0
US H10B	546H3 x C17	3,676	239.6	4,817	15.4	15.68	2.0
117H17	551H5 x C17	3,634	227.4	4,866	16.0	15.22	0.0
117H52	8522H1 x C17	3,508	234.6	4,634	14.9	15.50	0.0
117H62	8536H1 x C17	3,428	231.0	4,567	14.9	15.35	0.0
117H73	(564H0 x 9724) x C17	3,252	228.4	4,342	14.2	15.26	1.0
117H75	(9705H0 x 9724) x C17	3,029	234.0	4,012	13.0	15.47	1.0
Test Mean		3,781	234.0	5,002	16.2	15.47	1.8
LSD (0.05)		389	10.6	477	1.5	0.40	--
Coefficient of Variation - %		14	6.1	13	12.3	3.45	--
Standard Error of the Mean		140	3.8	171	0.5	0.14	--
F value		5.03**	2.50**	5.37**	5.52**	2.55**	--

VARIETY TEST, SOUTH SAN JOAQUIN, CALIFORNIA, 1972
(Results Extracted from Test of 17 Varieties)

9 replications, 1 row plots,
25 feet long, 30 inches between rows

Holly Sugar Corporation
Planted: February 15, 1972
Harvested: July 31, 1972

Variety	Description	Extractable Sugar/Acre	Extractable Sugar/Ton	Gross Sugar/Acre	Beets/ Acre	Sucrose	Beets/ 100 ft.
		Pounds	Pounds	Pounds	Tons	Percent	Number
117H17	551H5 x C17	8,534	257.9	10,230	33.1	15.46	171
US H10B	546H3 x C17	8,431	268.1	9,939	31.4	15.81	159
117H69	(564H0 x 9705) x C17	8,132	264.7	9,648	30.7	15.71	174
US H9	546H3 x C13	8,113	271.0	9,553	30.1	15.92	150
Y101H63	(564H0 x 8551) x Y001	7,857	261.4	9,345	29.9	15.58	164
Y101H8	546H3 x Y001	7,637	264.7	9,061	28.9	15.70	154
117H60	0534-3H52 x C17	7,588	273.5	8,879	27.7	16.01	181
117H52	8522H1 x C17	7,513	276.2	8,767	27.3	16.10	164
117H75	(9705H0 x 9724) x C17	7,501	262.3	8,936	28.7	15.60	154
117H73	(564H0 x 9724) x C17	7,406	259.2	8,890	28.8	15.50	161
US H10A	569H3 x C17	7,257	260.4	8,690	28.1	15.54	165
117H45	(6705H25 x 7718) x C17	7,245	253.5	8,732	28.4	15.31	166
117H62	8536H1 x C17	6,908	270.6	8,112	25.4	15.91	168
Test Mean		7,610	266.2	9,010	28.6	15.75	166
LSD (0.05)		NS	NS	NS	NS	NS	--
Coefficient of Variation - %		17	7.4	16	16.1	4.37	--
Standard Error of the Mean		438	6.6	493	1.5	0.23	--
F value		NS	NS	NS	NS	NS	--

VARIETY TEST, HAMILTON CITY, CALIFORNIA, 1972
(Results Extracted from Test of 17 Varieties)

Holly Sugar Corporation
Planted: February 25, 1972
Harvested: September 25, 1972

9 replications, 1 row plots,
25 feet long, 26 inches between rows

Variety	Description	Extractable Sugar/Acre	Extractable Sugar/Ton	Gross Sugar/Acre	Beets/ Acre	Sucrose	Beets/ 100 ft.
		Pounds	Pounds	Pounds	Tons	Percent	Number
US H9	546H3 x C13	7,090	197.7	9,474	35.9	13.21	160
117H52	8522H1 x C17	7,048	204.6	9,287	34.4	13.49	168
US H10B	546H3 x C17	7,042	204.1	9,291	34.5	13.46	165
117H45	(6705H25 x 7718) x C17	6,976	198.9	9,293	35.0	13.26	156
117H60	0534-3H52 x C17	6,678	202.2	8,851	33.1	13.39	170
117H62	8536H1 x C17	6,668	194.7	8,971	34.3	13.09	165
Y101H8	546H3 x Y001	6,656	198.5	8,877	33.5	13.24	141
117H73	(564H0 x 9724) x C17	6,562	199.9	8,726	32.8	13.30	155
117H75	(9705H0 x 9724) x C17	6,402	202.8	8,482	31.7	13.42	148
US H10A	569H3 x C17	6,289	200.0	8,358	31.4	13.31	160
117H69	(564H0 x 9705) x C17	6,263	196.1	8,384	31.8	13.14	162
Y101H63	(564H0 x 8551) x Y001	6,135	192.3	8,304	32.0	12.99	161
117H17	551H5 x C17	6,001	188.9	8,158	31.7	12.86	153
Test Mean		6,562	199.0	8,745	33.0	13.26	160
LSD (0.05)		NS	10.6	NS	NS	0.42	--
Coefficient of Variation - %		14	5.7	13	12.6	3.42	--
Standard Error of the Mean		296	3.8	375	1.4	0.15	--
F value		NS	2.92**	NS	NS	2.95**	--

VARIETY TEST, TRACY, CALIFORNIA, 1972
(Results Extracted from Test of 17 Varieties)

Holly Sugar Corporation
Planted: May 1, 1972
Inoc. with virus yellows: June 8, 1972
Harvested: October 2, 1972

9 replications, 1 row plots,
25 feet long, 30 inches between rows

Variety	Description	Extractable Sugar/Acre Pounds	Extractable Sugar/Ton Pounds	Gross Sugar/Acre Pounds	Beets/ Acre Tons	Sucrose Percent	Beets/ 100 ft. Number
117H45	(6705H25 x 7718) x C17	3,838	136.0	5,947	28.3	10.52	129
117H17	551H5 x C17	3,524	130.0	5,536	27.1	10.21	144
117H69	(564H0 x 9705) x C17	3,492	140.1	5,332	24.8	10.71	147
117H73	(564H0 x 9734) x C17	3,451	142.6	5,215	23.9	10.82	129
117H75	(9705H0 x 9724) x C17	3,436	137.0	5,304	25.2	10.56	129
117H52	8522H1 x C17	3,380	138.9	5,175	24.3	10.64	144
117H62	8536H1 x C17	3,316	142.6	5,023	23.2	10.82	135
117H60	0534-3H52 x C17	3,169	130.1	4,980	24.3	10.23	138
Y101H63	(564H0 x 8551) x Y001	3,165	127.4	5,012	24.8	10.10	133
US H10B	546H3 x C17	3,135	137.8	4,813	22.6	10.61	134
US H9	546H3 x C13	3,102	129.3	4,877	23.9	10.19	140
Y101H8	546H3 x Y001	3,016	129.9	4,731	23.1	10.21	136
US H10A	569H3 x C17	3,003	147.1	4,476	20.1	11.02	143
Test Mean		3,150	135.3	4,868	23.2	10.47	138
LSD (0.05)		602	13.4	819	3.3	0.64	--
Coefficient of Variation - %		20	10.6	18	15.4	6.55	--
Standard Error of the Mean		215	4.8	293	1.2	0.23	--
F value		4.10**	3.39**	4.88**	6.30**	3.40**	--

Leaf Spot and Curly Top Grades

Variety	Description	Holly Sugar Corporation Leaf spot[1/]	Curly top[2/]
US H9	546H3 x C13	3.3	3.3
117H52	8522H1 x C17	2.7	2.7
US H10B	546H3 x C17	4.0	3.3
117H45	(6705H25 x 7718) x C17	4.0	3.0
117H60	0534-3H52 x C17	3.7	1.7
117H62	8536H1 x C17	2.7	2.7
Y101H8	546H3 x Y001	4.0	4.3
117H73	(564H0 x 9724) x C17	3.0	2.7
117H75	(9705H0 x 9724) x C17	4.0	2.3
US H10A	569H3 x C17	3.3	3.3
117H69	(564H0 x 9705) x C17	3.7	2.7
Y101H63	(564H0 x 8551) x Y001	4.7	3.7
117H17	551H5 x C17	3.3	2.7

1/ Leaf spot ratings were made at Hereford, Texas.

2/ Curly top ratings were made at Sheridan, Wyoming.

DATA ON USDA VARIETIES TESTED BY SPRECKELS SUGAR - 1972

Test Areas:	Spreckels			Mendota, Calif.			Chandler, Arizona		
Variety	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar
US H9A	5.345	33.83	15.8	3.616	24.37	15.0	4.691	34.25	13.7
US H9B				4.095	28.58	14.4	4.481	34.18	13.1
US H10A	5.043	32.33	15.6	3.879	26.65	14.6	4.488	32.61	13.8
117 H52	4.680	30.59	15.3	3.923	28.07	14.2			
117 H62	4.379	30.62	14.3	3.958	27.62	14.5			
117 H69	4.613	30.15	15.3	3.896	26.73	14.6			
117 H75	4.177	26.95	15.5	3.514	24.90	14.2			
Y101 H8	4.700	29.56	15.9	3.048	20.75	14.8			
GENERAL MEAN	5.314	31.82	16.7	3.974	27.64	14.5	4.474	33.35	13.4
LSD @ P = .05	0.657	3.70	0.8	0.493	3.62	NS	0.419	2.99	0.4
LSD @ P = .01	0.830	4.67	1.0	0.623	4.58	NS	0.544	3.89	0.5
SE of Mean	0.251	1.414	0.29	0.188	1.384	0.283	0.153	1.096	0.148
SE % of Mean	4.78	4.44	1.76	4.74	5.01	1.95	3.43	3.29	1.10
# of Varieties in Test		16			16			8	
Planting Date		Jan. 7, 1972			Feb. 11, 1972			Sept. 23, 1971	
Harvest Date		Oct. 2, 1972			Sept. 14, 1972			June 27, 1972	

VARIETY TEST, CLARKSBURG, CALIFORNIA, FALL HARVEST, 1972

By American Crystal Sugar Company
22401

6 replications — Planted: April 15, 1972
2 row plots, 70 ft. long, 22 inch rows — Harvested: August 15, 1972

Variety	Description	Acre Yield Sugar	Acre Yield Sugar-KSL	Acre Yield Beets	Sucrose	Recov. Sugar/Ton	Amino N	Na	K	Impurity Index
		Pounds	Pounds	Tons	Percent	Pounds	PPM	PPM	PPM	
Y004H12B	F68-546H4 x Y904B	9,930	9,360	29.36	16.9	318	218	282	1424	385
Y101H8	546H3 x Y001A,B	9,670	9,000	28.79	16.8	314	246	370	1679	457
Y004H12	F68-546H4 x Y904A	9,450	8,910	28.43	16.6	314	203	293	1393	381
117H73	0724H5 x C17	9,260	8,720	28.17	16.5	310	205	275	1429	388
117H16	F68-546H5 x C17	9,080	8,540	26.99	16.8	317	221	284	1498	400
Y101H69	0705H5 x Y001A,B	8,860	8,320	25.51	17.4	326	230	351	1525	409
US H10B	546H3 x C17	8,770	8,290	26.07	16.8	318	189	281	1405	368
117H52	8522H1 x C17	8,760	8,300	25.79	17.0	322	190	238	1365	351
110H69	0705H5 x 910	8,610	8,110	26.06	16.5	311	209	388	1291	392
117H69	0705H5 x C17	8,600	8,130	25.29	17.0	321	188	294	1367	362
US H10A	569H3 x C17	8,590	8,100	25.82	16.6	314	203	255	1412	376
117H62	8536H1 x C17	8,390	7,920	25.04	16.8	316	189	303	1428	378
Mean		9,000	8,470	26.78	16.8	317	207	301	1435	387
LSD (.05)		837.0	766.6	2.45	NS	NS	35.1	39.0	100.1	31.9
Coefficient of Variation (%)		8.0	7.8	7.9	3.4	3.5	14.6	11.2	6.0	7.1
F value		2.7**	2.6**	3.1**	NS	NS	2.2*	11.0**	7.7**	5.9**

* Exceeds the 5% point of significance (F = 1.98)
** Exceeds the 1% point of significance (F = 2.62)
KSL = Known Sugar Loss

VARIETY TEST, CLARKSBURG, CALIFORNIA, FALL HARVEST, 1972

By American Crystal Sugar Company
22402

6 replications
2 row plots, 70 ft. long, 22 inch rows

Planted: April 15, 1972
Harvested: August 15, 1972

Variety	Acre Yield Sugar	Acre Yield Sugar-KSL	Beets	Sucrose	Recov. Sugar/Ton	Amino N	Na	K	Impurity Index
	Pounds	Pounds	Tons	Percent	Pounds	PPM	PPM	PPM	
68313 x 813T	8,320	7,830	24.65	16.9	319	173	521	1278	390
68314 x C413	8,030	7,600	23.01	17.5	330	164	485	1221	356
68313 x C413	7,840	7,400	22.94	17.3	327	174	439	1210	358
US H9B	7,830	7,370	23.41	16.8	316	180	507	1267	392
68313 x 65202B	7,370	6,980	20.36	18.2	344	183	469	1197	347
HH22	7,340	6,930	22.04	16.8	318	179	361	1244	359
63(5HO x 6) x 65-202B	7,190	6,810	19.71	18.3	346	179	543	1156	351
F66-569H3 x 67-436	7,160	6,770	19.07	18.9	357	244	404	1315	367
68-313 x 64-208	7,120	6,750	19.57	18.2	345	165	456	1250	341
(562HO x 546) x 67-436	7,070	6,710	18.74	18.9	359	225	373	1243	341
US H10B	7,060	6,670	20.88	17.0	321	178	414	1192	357
HH23	6,630	6,310	18.73	17.7	337	152	368	1243	325
Mean	7,410	7,010	21.09	17.7	335	183	445	1235	357
LSD (.05)	NS	NS	3.38	0.68	13.9	29.8	83.3	NS	NS
Coefficient of Variation (%)	12.0	11.7	13.83	3.33	3.6	14.1	16.1	6.9	9.4
F value	NS	NS	2.95**	10.29**	9.5**	6.1**	4.5**	NS	NS

** Exceeds the 1% point of significance (F = 2.62)
KSL = Known Sugar Loss

VARIETY TEST, DIXON, CALIFORNIA, FALL HARVEST, 1972

By American Crystal Sugar
22405

6 replications
2 row plots, 70 ft. long, 22 inch rows

Planted: April 15, 1972
Harvested: August 19, 1972

Variety	Description	Acre Yield Sugar	Acre Yield Sugar-KSL	Acre Yield Beets	Sucrose	Recov. Sugar/Ton	Amino N	Na	K	Impurity Index
		Pounds	Pounds	Tons	Percent	Pounds	PPM	PPM	PPM	
Y004H12B	F68-546H4 x Y904B	13,830	12,560	43.78	15.8	287	356	439	2005	618
Y004H12	F68-546H4 x Y904A	12,610	11,350	40.37	15.6	282	370	486	2129	664
US H10A	569H3 x C17	12,410	11,290	38.61	16.1	292	339	425	2064	603
US H10B	546H3 x C17	12,380	11,250	38.16	16.3	295	340	456	2105	611
Y101H69	0705H5 x Y001A,B	12,100	10,970	36.83	16.5	298	357	554	2037	622
117H16	F68-546H5 x C17	11,940	10,840	38.43	15.6	282	302	488	2056	616
Y101H8	546H3 x Y001A,B	11,910	10,620	38.40	15.5	277	382	606	2273	724
117H73	0724H5 x C17	11,820	10,770	35.18	16.8	307	385	453	1943	590
110H69	0705H5 x 910	11,810	10,690	37.06	15.9	288	325	695	1889	634
117H69	0705H5 x C17	11,370	10,320	35.24	16.1	292	341	528	1995	616
117H52	8522H1 x C17	11,310	10,330	35.92	15.8	288	320	466	1825	577
117H62	8536H1 x C17	10,910	9,970	34.56	15.8	289	305	492	1802	569
Mean		12,030	10,910	37.71	16.0	290	343	507	2010	620
LSD (.05)		1,143	1,021	3.71	0.78	15.4	NS	77.2	167.4	55.7
Coefficient of Variation (%)		8.2	8.1	8.49	4.23	4.6	14.7	13.1	7.2	7.7
F value		3.5**	3.4**	3.88**	2.00*	2.2*	NS	8.3**	5.1**	4.4**

* Exceeds the 5% point of significance (F = 1.98)
** Exceeds the 1% point of significance (F = 2.62)
KSL = Known Sugar Loss

VARIETY TEST, DIXON, CALIFORNIA, FALL HARVEST, 1972

By American Crystal Sugar Company
22406

6 replications
2 row plots, 70 ft. long, 22 inch rows

Planted: April 15, 1972
Harvested: August 19, 1972

Variety	Acre Yield Sugar	Acre Yield Sugar-KSL	Acre Yield Beets	Sucrose	Recov. Sugar/Ton	Amino N	Na	K	Impurity Index
	Pounds	Pounds	Tons	Percent	Pounds	PPM	PPM	PPM	
68314 x C413	15,250	13,730	48.10	15.9	286	374	463	2251	668
US H9B	15,180	13,870	45.85	16.6	303	355	313	2073	572
68313 x C413	14,040	12,810	42.79	16.4	299	375	356	1986	585
HH23	13,920	12,880	41.01	17.0	314	310	266	1905	500
68313 x 813T	13,430	12,220	43.06	15.6	284	291	401	2114	598
68-313 x 64-208	13,290	12,100	41.14	16.2	294	340	395	2103	599
US H10B	13,240	12,140	40.80	16.2	297	357	302	1893	554
68313 x 65202B	13,050	11,900	38.15	17.2	313	407	360	2053	586
HH22	13,050	11,960	40.97	15.9	291	353	287	1873	558
63(5HO x 6) x 65-202B	12,770	11,670	35.86	17.8	326	406	402	2083	573
(562HO x 546) x 67-436	12,320	11,380	33.72	18.3	338	418	287	1798	506
F66-569H3 x 67-436	11,810	10,920	32.04	18.5	341	382	294	1895	498
Mean	13,450	12,300	40.29	16.8	307	364	344	2002	567
LSD (.05)	1,727	1,598	5.37	0.81	15.9	NS	70.3	183.7	64.0
Coefficient of Variation %	11.1	11.2	11.49	4.16	4.5	22.6	17.6	7.9	9.7
F value	2.9**	2.5*	6.19**	11.47**	12.0**	NS	6.2**	3.1**	4.7**

* Exceeds the 5% point of significance (F = 1.98)
** Exceeds the 1% point of significance (F = 2.62)
KSL = Known Sugar Loss

INTERSPECIFIC HYBRIDIZATION

VULGARIS-PROCUMBENS HYBRIDS

Helen Savitsky

The progenies of B_4 and B_5 vulgaris-procumbens trisomics were tested for nematode resistance. The test included 1,408 plants which were grown in nematode infested soil in the greenhouse. After three tests 169 (12%) resistant plants were selected. The chromosome number was determined in each of these plants and all but one had 19 chromosomes. Only one diploid nematode resistant plant was found in the progenies of the trisomics.

Chromosome numbers were also counted before flowering in 230 plants previously selected in 1971 from the progenies of nematode resistant backcross plants classified as diploids. These plants were considered to be diploids; however, cytological examination showed they were trisomics with the exception of one plant which had 18 chromosomes. Apparently, the majority of the parent plants were not diploids but were trisomics. Some of 19 chromosome plants could also have arisen from contamination with the pollen of trisomics.

This year's cytological studies showed that few resistant diploid plants occur in the progenies of resistant trisomics. Crossing over between B. vulgaris and B. procumbens chromosomes apparently is very rare. Many new morphological types of trisomics were obtained. Plants were observed with long leaves, with long drooping petioles, and with short erect petioles. In some plants the leaves were short and wide; but in the majority of the trisomics the leaves were typically narrow and elongated, dark green, and often glossy. After the seed was harvested, trisomic plants were maintained in the greenhouse until the rosettes were developed. They were then exposed to thermal induction to obtain an additional seed crop.

The fertility of trisomics is influenced more by environment than is the fertility of diploids. Trisomics are more sensitive to temperature changes during seed stalk and bud development. In certain plants many seeds were set on some branches, whereas flowers on other branches of the same plant remained almost sterile. Plants which flowered the second time often developed a large number of seed stalks with many buds. Because of insufficient nutrition, seed set and seed germination was usually poor. The surplus seed stalks should be removed from such plants.

Variation in fertility can also cause variation in the percent of transmission of the B. procumbens chromosome; and, consequently, in the percent of resistant plants obtained from the progenies of individual trisomics. Some trisomics did not transmit the resistance. Usually such plants were low in fertility and their progenies consisted of few (3-20)

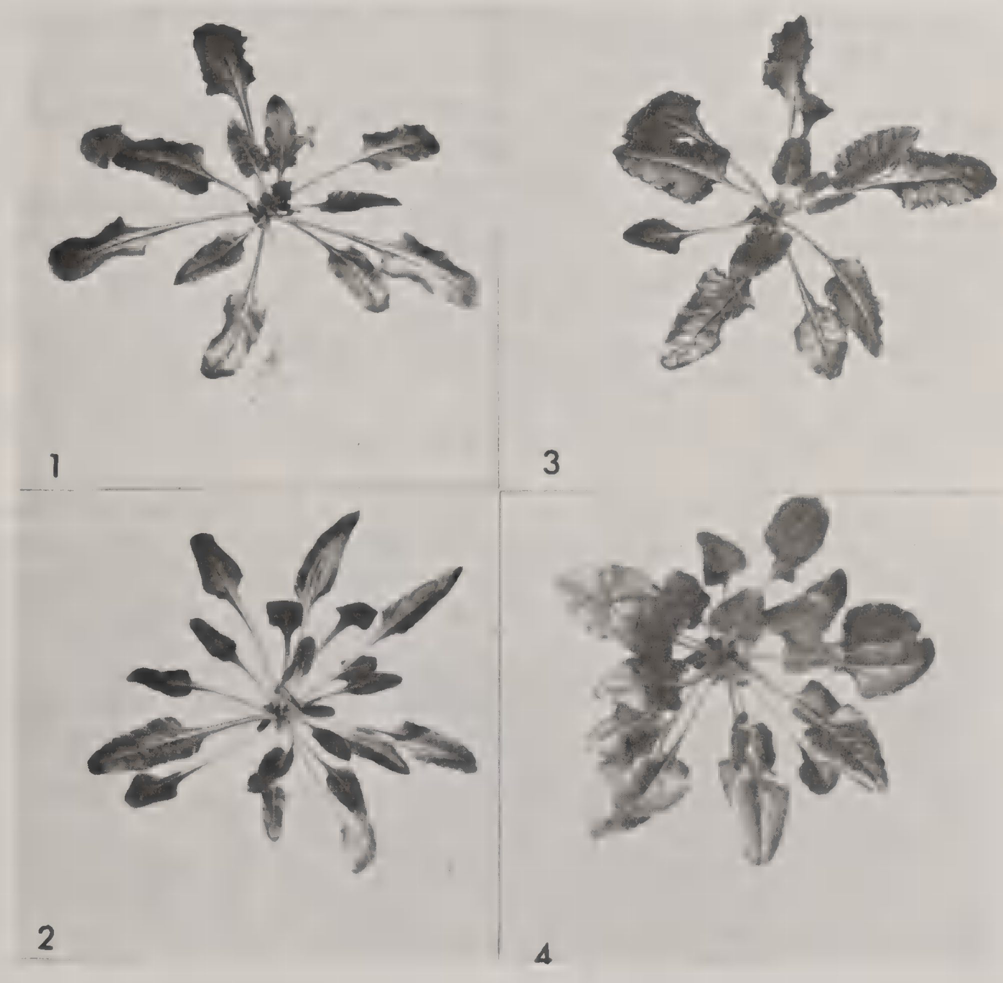
plants. However, the great majority of the trisomics transmitted the B. procumbens chromosome and the nematode resistance. Resistance transmission varied in different plants from 6.25% to 17.79%. The average transmission was about 12%.

Transmission of resistance by male and female gametes was compared. Eight nematode susceptible diploid plants and eight nematode resistant trisomics were bagged and two weeks later interpollinated by exchanging the bags. In five matings the diploid plants set seed after pollination with trisomics. Five bagged trisomics remained sterile, or some of the seed failed to germinate. Because of the apparent low fertility of the trisomics, the fertility of these plants was even more depressed by bagging. The progenies of five diploid plants derived from these crosses consisted of 255 nematode susceptible and one nematode resistant plant (0.4%).

In three other matings seeds were set on both partners of hybridization. Progenies of diploid plants from these three crosses consisted of 77 susceptible plants, 47 susceptible plants, and 88 susceptible plus one resistant plant (1.1%). The progenies of the corresponding trisomic partners of hybridization consisted of 11 susceptible plants, 33 susceptible plus six resistant plants (15.9%), and 67 susceptible plus ten resistant plants (12.9%).

Four diploid nematode susceptible plants were allowed to flower under open pollination among trisomic hybrids. The progenies of two plants contained 260 offspring which were all nematode susceptible. Among 148 offspring of the third plant, two plants (1.4%) were resistant and of 205 progeny of the fourth plant, three plants (1.5%) were resistant. The pollen grains in trisomics are often poor, and frequently diploid pollinators were put among them to obtain seed. Ordinarily, the B. procumbens chromosome which carries nematode resistance is transferred by female gametes. It could be expected that pollen grains with an extra chromosome would be less successful in competition with diploid pollen grains. Transmission through pollen grains sometimes occurs but is less frequent. For this reason, it may be desirable to pollinate the trisomics with pollen from productive commercial beets.

The B. procumbens chromosome has been transferred from generation to generation and has now been transferred to the B_6 generation. Ninety-eight B_6 trisomics resistant to nematode have been selected. About 210 B_4 and B_5 trisomics are also maintained. The populations of nematode resistant trisomics should be maintained by selection accompanied by cytological study. Because of the difficulties of obtaining nematode resistant diploid plants from crossing over, artificial methods of inducing translocations between B. vulgaris and B. procumbens chromosomes should be undertaken. To accomplish this, not only the inflorescences of trisomics, but also dry and pregerminated seed of trisomics have been irradiated with gamma rays in the Lawrence Radiation Laboratory. The dosages ranged from 500 R to 3000 R. One hundred and ten resistant plants were selected after two tests of plants from irradiated seed. The chromosome number of these plants is yet to be determined.



Different morphological types of _vulgaris_-_procumbens_ trisomics. Type 2 occurs most frequently.

VULGARIS-COROLLINAE HYBRIDS

Helen Savitsky and J. S. McFarlane

Vulgaris-corolliflora hybrids. The 15 B_4 plants highly resistant to curly top that were obtained last year had 19 chromosomes. Pollen development and fertility were much better in these B_4 plants than in B_2 and B_3 generations. I requested Dr. James Read to examine about 50 of the B_4 plants which showed mild curly top symptoms and he found plants with both 18 and 19 chromosomes.

Seeds have been harvested separately from the highly resistant B_4 plants and from the plants which showed mild curly top symptoms. Seeds obtained from highly resistant plants were planted and 195 young plants were tested for curly top resistance. Plants were twice inoculated with the highly virulent 66-10 strain of curly top virus. Dr. McFarlane inoculated and selected plants for resistance. The B_5 population was highly resistant to curly top. In this population 12 plants have been selected without any curly top symptoms and 120 plants with extremely mild symptoms. Sixty-three plants which were either weak or showed moderate symptoms were discarded. Chromosome numbers were counted in the resistant plants and four plants had 18 chromosomes.

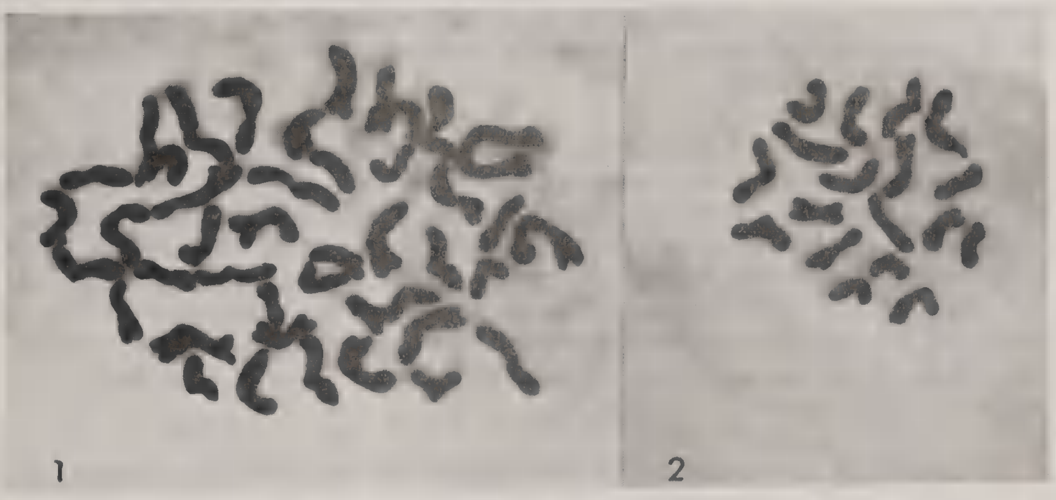
The highly resistant plants were checked by Dr. Duffus for immunity to curly top. Some nonviruliferous leafhoppers were allowed to feed on the plants and others on the beets infected with the 66-10 strain. Both groups of leafhoppers were then put in cages for seven days on the leaves of a very curly top susceptible sugarbeet strain. The leafhoppers which fed on the curly top infected plants transferred the virus, but no symptoms of curly top were observed on the plants with leafhoppers from the B_5 plants. Apparently, the B_5 plants are immune to curly top virus.

Vulgaris-trigyna hybrids. The hybrids previously designated as *vulgaris*-*macrorhiza* are really *vulgaris*-*trigyna* hybrids. The F_1 plants of this hybrid were derived from a cross between a tetraploid sugarbeet and a plant labeled *B. macrorhiza*. Apparently, the seed sample of *B. macrorhiza* which was received by V. F. Savitsky also contained seed of other species. Root tips were collected this year from F_1 hybrids and the cells of these roots had 45 chromosomes. This chromosome number could be obtained only from crosses of 36 chromosome sugarbeet with 54 chromosome *B. trigyna*. All F_1 hybrid plants were male-sterile, but were highly female fertile when pollinated with pollen from diploid sugarbeets. Seed germination was good and many B_1 plants were obtained last year.

The B_1 plants were highly resistant to curly top and 85 resistant plants were selected. Dr. Duffus checked the resistant B_1 plants for immunity to curly top by the method described for the *vulgaris*-*corolliflora* hybrids. The leafhoppers which fed on B_1 plants did not transfer the virus.

Apparently, these backcross plants are also immune to curly top. In addition to curly top resistance, the B_1 plants also have excellent vigor. The B_1 seed beets were seven feet tall, and developed many branches and flowers. All B_1 plants were completely male-sterile and female fertility was not high. However, enough seeds were obtained to produce the next generation.

The B_2 progenies are being tested for curly top resistance. Inoculation of plants with curly top virus isolate 66-10 and selection for resistance is being done by Dr. McFarlane. The B_1 generation was comparatively uniform in vigor and in curly top resistance, but the B_2 generation showed a wide range of diversity for these characters. A study of plant type showed that there are vigorous plants with large leaves, small plants, and plants of intermediate size. Both curly top resistant and curly top susceptible plants were observed. This diversity in characters is obviously caused by the distribution of different chromosomes among different gametes, and by the loss of some chromosomes in meiosis of B_1 plants. A cytological study of these plants should explain the process of chromosome distribution in the B_1 generation. Selection for vigor and for curly top resistance in the B_2 generation is very important if the chromosomes responsible for these characters are to be maintained in the population.



1. Chromosomes in the root tips of F_1 vulgaris-trigyna hybrids - 2x=45.
2. Chromosomes in the root tips of B_5 diploid curly top resistant vulgaris-corolliflora hybrids - 2x=18.

Investigation of B_3 Generation of *Beta vulgaris* x *B. procumbens* Hybrids

James C. Read

In the genera *Beta* resistance to sugarbeet nematode (*Heterodera schachtii*) occurs in the section *Patellares*. Viable F_1 hybrids between sugarbeet and *B. procumbens*, a resistant species, was obtained by Helen Savitsky. The F_1 was resistant and by backcrossing to sugarbeet, all the *B. procumbens* chromosomes were eliminated except for one which carries the gene or genes for resistance (1969 Sugarbeet Research Report).

Seeds from these 19 chromosome B_2 *vulgaris* x *procumbens* plants were obtained from H. Savitsky in the summer of 1971. Since then, a total of 2,895 plants from 36 different progenies were tested (Table I). Plants were tested through three cycles by the Doney and Whitney method (1). A germination and/or seedling disease problem occurred which accounts for the small number of plants observed in some of the progenies. There were 389 resistant plants and all but ten had 19 chromosomes. Four had 18 chromosomes, two had 18 chromosomes plus a fragment, three had 28 chromosomes and one had 26 chromosomes. Advance generations of these 18-chromosome types have not been obtained and it is not known if they represent a crossover and an exchange of gene or genes for resistant, loss of one of the sugarbeet chromosomes, or an escape in testing.

Meiosis of the 19 chromosome-resistant plants revealed no definite trivalents. In most cases the extra chromosome was not on the metaphase plate with the nine pairs of sugarbeet chromosomes. In rare cases there was a thin strand of chromatin connecting the extra chromosome to a pair of sugarbeet chromosomes. This indicates that whatever homology exists is so slight that only a small (probably terminal) segment of the extra chromosome is able to associate with a sugarbeet chromosome. Thus, there seems to be a very low probability of obtaining the desired crossover.

To increase the chances of obtaining the desired crossover, radiation studies have been initiated. Both plants and seeds have been irradiated through use of the facilities at the Lawrence Radiation Laboratory, Berkeley, California. Seeds were irradiated dry and soaked for 24 hours at 500r, 1,000r, 1,500r, and 2,000r. Plants were grouped as to time before anthesis and given the same doses as the seeds. The groupings were: (1) just prior to anthesis, (2) two to four days from anthesis, and (3) about a week from anthesis. Progenies from these have not been evaluated, but seeds from the irradiated plants have been harvested.

A study of meiosis after irradiation revealed little effect from the 500r dose with an increase in the number and degree of aberrations at each level of radiation. At 2,000r some effect was observed in each cell studied. The effects consisted of trivalents, quadivalents and higher associations at metaphase and bridges and fragments at anaphase. Seed production from these plants tends to support the meiotic studies. Good seed set was obtained from the 500r dose and very little from the 2,000r dose except for the plant which already had undergone meiosis. Based on this limited data plants should be irradiated with a dose of 1,000r to 1,500r at the stage when the greatest number of flowers are in meiosis. It is hoped with these and future radiation studies an exchange carrying the gene or genes for resistance can be obtained.

LITERATURE CITED

1. Doney, D. L. and E. D. Whitney. 1969. Screening Sugarbeet for Resistance to Heterodera schachtii Schm. J. Am. Soc. Sugar Beet Technol. 15: 546-552.

Table I. Results of Progeny Tests for Nematode Resistance.

Parent No.	Total No. of Plants	No. of Sus. Plants	No. of Res. Plants	% Res.
8004	93	73	20	21.50
7139	109	104	5	4.60
7278	37	31	6	16.20
6809	29	26	3	10.30
9130	16	15	1	6.25
7120	33	32	1	3.03
7265	54	51	4	7.41
8992	70	67	3	4.29
7089	114	109	5	4.39
7191	59	52	7	11.86
8922	126	125	1	7.94
8923	55	51	4	7.27
7138	99	88	11	11.11
7000	235	215	20	8.51
6901	90	76	14	15.56
7067	91	72	19	20.88
8994	53	50	3	5.66
7264	133	128	5	3.76
8877	108	85	23	21.30
7071	71	61	10	14.08
7094	83	64	19	22.89
10138	64	51	13	20.31
8878	60	53	7	11.67
10126	29	27	2	6.90
7094	14	5	9	64.28
8809	15	13	2	13.33
10106	173	142	31	17.92
6955	93	66	27	29.03
9410	154	144	20	12.99
8050	129	109	20	15.50
6978	44	36	8	18.18
6777	62	51	11	17.74
8163	19	18	1	5.26
9690	53	40	13	24.53
6800	35	29	6	17.14
7265	193	158	35	18.13
Total	2,895	2,506	389	13.44

VIRUS INVESTIGATIONS

Characterization of the beet curly top virus

James E. Duffus

The curly top viruses are known to occur in arid areas of the United States, South America, and Mediterranean Eurasia, but the geographical and ecological extent of their individual distribution is not known. These viruses resemble each other closely in symptoms induced on sugarbeet, but the relationships with certain hosts and with the insects that transmit them are so specific and so different in the areas of their occurrence as to raise questions as to their true relationships.

Because plant and insect quarantines prevent direct comparison of the virus entities by transmission tests, the application of serology to the study of curly top virus strains was initiated in cooperation with Dr. A. H. Gold, University of California, Berkeley, as a first step to determine relationships of the curly top viruses.

Materials and Methods: Isolates of curly top virus used in these studies were maintained in beet leafhoppers, *Circulifer tenellus* (Baker), reared on diseased plants. Young adult leafhoppers of ca. the same age reared on healthy plants were used in membrane feeding tests. The nonviruliferous leafhoppers were obtained by placing about 200 nonviruliferous adults on individual beet plants for 2 days. The leafhoppers were removed, and the eggs were allowed to hatch. The resulting nymphs were all about the same age.

Membrane-feeding tests were conducted, using feeding cages modified from earlier models (1, 7). The bottoms of plastic vials, 5 cm in diam., were cut, leaving a cylinder 5 cm long. To the cut end of the cylinder a fine-mesh screen was attached. The cap end of the vial was covered with a thin membrane of Parafilm (Marathon Products, Neenah, Wisconsin). Groups of 26 nonviruliferous leafhoppers were placed in these cages. Approximately 0.5 ml of the liquid extract to be tested was placed on the membrane and covered with another thin membrane of Parafilm. Extracts were adjusted to 15% sucrose by the addition of sucrose or dilution with buffer. Cages with leafhoppers and liquid extract were placed on white paper, membrane-side down, in a controlled temperature chamber maintained at 37° C. The leafhoppers were allowed to feed 4 hr on the extracts and then caged singly on seedling beets.

Extracts for antigen preparation and infectivity neutralization tests were derived from phloem exudate, collected from curly top-infected shepherd's purse, *Capsella bursa-pastoris* (L.) Medic (2). Exudate was clarified by low speed centrifugation (10 min at 8,000 rpm, 4,220 g) and frozen until used.

Density-gradient centrifugation was done in a SW-25.1 rotor for 10 hr at 23,000 rpm (53,819 g). Gradient columns were prepared by layering 4, 7, 7, and 7 ml of 10, 20, 30, and 40% sucrose, respectively, dissolved in 0.05 M phosphate buffer, pH 7.0, containing 0.01 M glycine. Columns were fractionated with an ISCO Density-Gradient Fractionator.

The density-gradient electrophoresis apparatus used was similar to that described by van Regenmortel (14). Phloem exudate was dialized against 35% sucrose in 0.005 M phosphate buffer, pH 8.0. The dialized phloem exudate was layered between 50% sucrose in 0.005 M phosphate buffer and the bottom of the gradient. The gradient column was formed with 0.005 M phosphate buffer and 35% sucrose in the same buffer. Electrophoresis was conducted at a constant amperage of 7.5 mA for 22 hr. The columns were fractionated in 1-ml aliquots, and each fraction was assayed for virus infectivity by feeding leafhoppers on the extracts.

Healthy shepherd's-purse antigen was prepared by clarifying crude extracts by low-speed centrifugation (10 min at 6,000 rpm, 4,200 g) followed by ultracentrifugation (2 hr at 35,000 rpm, 80,800 g). The pellets were resuspended in 1/150 of the original volume of buffer.

Beet curly top virus antigen was prepared in two ways. In one method, crude phloem exudate was clarified and injected into rabbits. The second method used the most infectious zone of several density-gradient electrophoresis runs as the antigen.

Sera were prepared from the antigen preparations by 6 intramuscular injections of rabbits at weekly intervals, using Freund's complete adjuvant (Difco Bacto).

<u>Results</u>: <u>Correlation of particles and infectivity</u>.--The curly top virus is extremely stable, but attempts to study the nature of the infectious particle have been hampered by its apparent highly adsorptive qualities (3). Phloem exudate, because of its high virus content and its usefulness as a leafhopper-feeding extract (1) was used as a starting material to establish a correlation between particles and infectivity.

Density-gradient centrifugation of clarified phloem exudate resulted in infectivity in all layers in the density-gradient columns (Table 2). Moreover, absorbence in the ISCO Density-Gradient Fractionator and Scanner was obscured by light-absorbing components low in the columns.

Because of the difficulty in obtaining one infective band by density-gradient centrifugation, dialized phloem exudate was subjected to density-gradient electrophoresis. The virus, as evidenced by infectivity tests, migrated well in the electrophoresis columns. Although the electrophoresis fractions containing virus varied somewhat in their position in the columns in different runs, the zone with the highest infectivity appeared, in electron-microscope observation, to be completely separated from other particulate material. Infectivity was generally found 6-24 cm from the origin, with the region of highest infectivity 14-17 cm from the origin.

The region of highest infectivity showed one type of particle in shadowed preparations--small, spherical, spongy-appearing particles ca. 19-20 nm in diameter and occurring mostly in clumps (Fig. 1). The particles are similar to particles found by K. M. Smith and C. W. Bennett from phloem exudate passed through gladocol membranes with estimated pore sizes of ca. 25 nm (3). Characteristic particles were absent from zones with no infectivity.

Infectivity neutralization.--Serological neutralization of infectivity (11) was conducted in two ways. In the first, insects were fed directly on the virus-antiserum reactants. This technique demonstrates virus neutralization. In the second method, the virus-antiserum reactants were subjected to density-gradient centrifugation before the feeding of insects. Since earlier work with density-gradient centrifugation had indicated infectious zones scattered throughout the gradient columns, all zones were fed to insects. This technique also demonstrates virus neutralization. The procedure for the first method consisted of mixing clarified phloem exudate, or partially purified electrophoresis fractions, with an equal volume of buffer, normal rabbit serum, antiserum to the juice of healthy shepherd's purse, or antiserum to the virus. After incubation for 2 hr at 37°, the mixture was fed to nonviruliferous beet leafhoppers through membranes. The beet leafhoppers were caged individually on sugarbeet seedlings. Infectivity of three curly top virus isolates was almost completely neutralized with antiserum CT-1 (produced against curly top phloem exudate), but only partially with antiserum CT-E (produced against curly top electrophoresis zones) (Tables 1, 2). Normal rabbit serum or antiserum against healthy shepherd's purse juice had little effect on infectivity.

Another experiment was designed to measure the titer of antiserum (CT-1) against strain 11 of the curly top virus (Table 3). The reaction was carried out using phloem exudate diluted to 15% sucrose with buffer. Antiserum was diluted with 0.85% NaCl in series to 4^{-5} the original concentration. The dilutions of antiserum were incubated with the diluted phloem exudate for 2 hr at 37° and fed to leafhoppers. Dilutions of antiserum to 2^{-1} effectively neutralized this concentration of the curly top virus. The dose of antiserum that neutralized half the infectivity was determined to be a dilution between 4^{-2} and 4^{-3}.

Table 1. Infectivity neutralization of beet curly top virus isolates

Sample Tested	Infectivity of isolates after incubation with the indicated diluent		
	Strain 11	Isolate 8	Isolate 22
Buffer + virus[a]	76[b]	72	84
Normal serum + virus	79	69	79
ASHSP[c] + virus	69	75	74
ASCT-1 + virus	1	0	0
ASCT-E + virus	31	28	41

[a] Dialized phloem exudate was subjected to density-gradient electrophoresis. The most highly infectious zones in bands 14-17 cm from the origin were pooled and frozen until use. The virus sample was diluted with buffer to 15% sucrose and then mixed with an equal volume of the indicated diluent and incubated for 2 hr at 37°.

[b] Number of plants infected out of 200 inoculated by individual beet leafhoppers fed through a membrane on each sample.

[c] Antiserum to healthy shepherd's purse (ASHSP); antiserum to Strain 11 curly top virus prepared against phloem exudate (ASCT-1); antiserum to Strain 11 curly top virus prepared against density-gradient electrophoresis fractions (ASCT-E).

Table 2. Infectivity neutralization of beet curly top virus followed by density-gradient centrifugation

Density-Gradient Zones[a]	Infectivity of zone after incubation with the indicated diluent		
	Buffer	Normal Serum	ASCT-1
2	2[b]	1	0
4	3	3	0
6	2	2	0
8	4	1	0
10	3	3	0
12	8	3	0
14	6	12	0
16	7	6	0
18	4	6	0
20	6	8	0
22	3	4	0
24	4	4	0
26	3	2	0
28	1	3	0
30	0	1	0

[a] Dialized phloem exudate was diluted to 15% sucrose with buffer, and the virus sample was mixed with an equal volume of the indicated diluent and incubated for 2 hr at 37°. The virus-antiserum reactants were subjected to density-gradient centrifugation and fractionated.

[b] Number of plants infected out of 16 plants inoculated in 2 tests by individual beet leafhoppers fed through a membrane on each sample.

Table 3. Effect of serum dilution on infectivity neutralization of beet curly top virus

Sample Tested	Infectivity of sample after incubation with the indicated serum dilution
ASHSP[a] + virus[b]	72[c]
ASCT-1 + virus	3
ASCT-1 2^{-1} + virus	0
ASCT-1 4^{-1} + virus	18
ASCT-1 4^{-2} + virus	28
ASCT-1 4^{-3} + virus	57
ASCT-1 4^{-4} + virus	70
ASCT-1 4^{-5} + virus	63

[a] Antiserum to healthy shepherd's purse (ASHSP); antiserum to Strain 11 curly top virus prepared against phloem exudate (ASCT-1). Serum dilutions were made with 0.85% NaCl.

[b] Virus sample was phloem exudate diluted with buffer to 15% sucrose.

[c] Number of plants infected out of 145 inoculated by individual beet leafhoppers fed through a membrane on each sample.

Discussion: A systematic study of the geographic distribution and interrelationships of the curly top viruses, which cause serious disease losses on several major world food crops (13), could be economically and scientifically important. The viruses appear to occur in several well defined areas (4, 5, 6). They show several strong similarities, yet there are differences that raise questions concerning their true relationships and their areas of origin. The only known vector of curly top virus in North America is the leafhopper, Circulifer tenellus. This species has no close relatives in the New World (12). Curly top virus in Turkey and Iran has been transmitted by C. tenellus and C. opacipennis (Lethierry) (3). The close relatives of C. tenellus are indigenous to the Old World (12). This information indicated to Bennett (6) that North American curly top virus probably originated in Mediterranean Eurasia along with its vector. The South American curly top viruses are transmitted by leafhoppers (Agalliana ensigera Oman, Agallia albidula Uhl, and Agallia sticticollis) not closely related to C. tenellus. Thus, we have the apparent paradox of curly top viruses in different parts of the world, very similar in many of their properties, and highly specific in their relationships with the insects that transmit them; yet, the South American curly top viruses are distinguished from the others by their dependence for transmission on leafhoppers that are quite unrelated to the beet leafhopper of other parts of the world.

A serological approach to a geographic study of the various curly top viruses would be especially valuable. The studies reported herein indicate that curly top virus is immunogenic and may be tested by one of the most specific of all virus-antibody reactions--neutralization. Neutralization of infectivity by immune sera has greatly aided in the clarification of some of the interrelationships of the yellowing viruses of the beet western yellows group (8, 9, 10, 11). It is a sensitive test and can be used for demonstrating serological relationships where the precipitation test cannot be applied. It also has the advantages that antibodies to normal plant constituents do not affect the usefulness of the serum and that it detects active virus.

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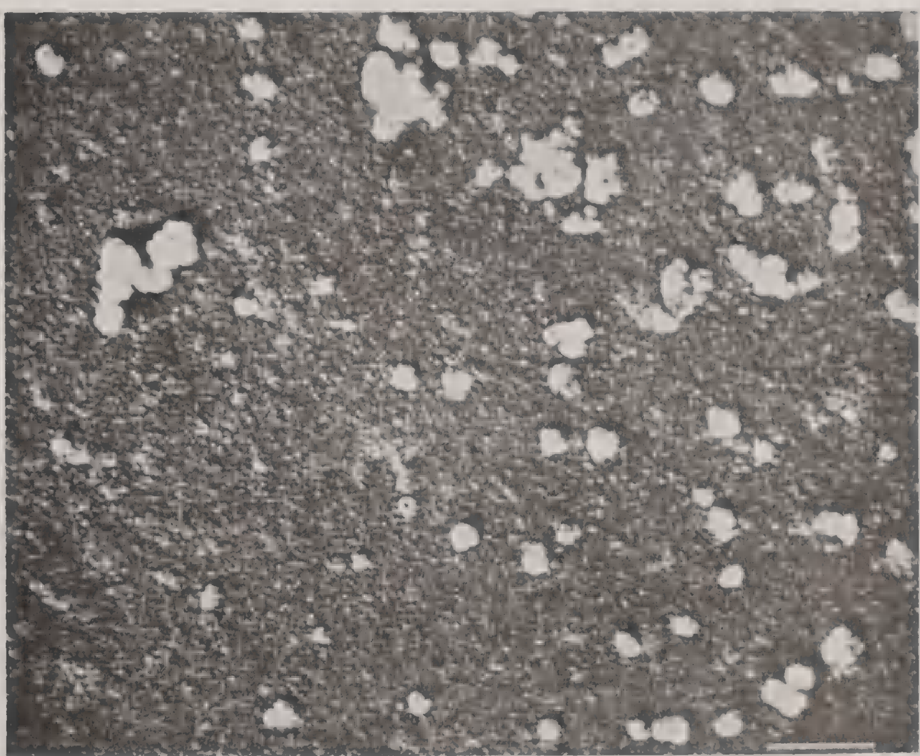


Fig. 1. Electron micrograph of shadowed beet curly top virus particles. Bar represents 100 nm.

Ultrastructure of Tapetal Cell Degeneration in Normal and CMS Anthers of Sugarbeet

Lynn L. Hoefert

Normal tapetal cells differentiate from sporogenous cells early in anther ontogeny. The tapetal cells divide just before meiosis to become binucleate cells, rich in cytoplasm, and separated from each other and the developing microspores by anticlinal and radial walls (fig. 1). At the time the tetrad cells separate, (through dissolution of the callose wall) the tapetal cell walls also disintegrate and naked tapetal protoplasts form a single cell layer around the microspores. At this stage, the tapetal cells are enclosed merely by a cell membrane or plasmalemma (fig. 2).

The dark exine or pollen wall material (termed sporopollenin) is deposited on the microspores. The tapetal cells at this stage appear cytologically active and are thought to provide secretory nutrients to the developing microspores (fig. 3).

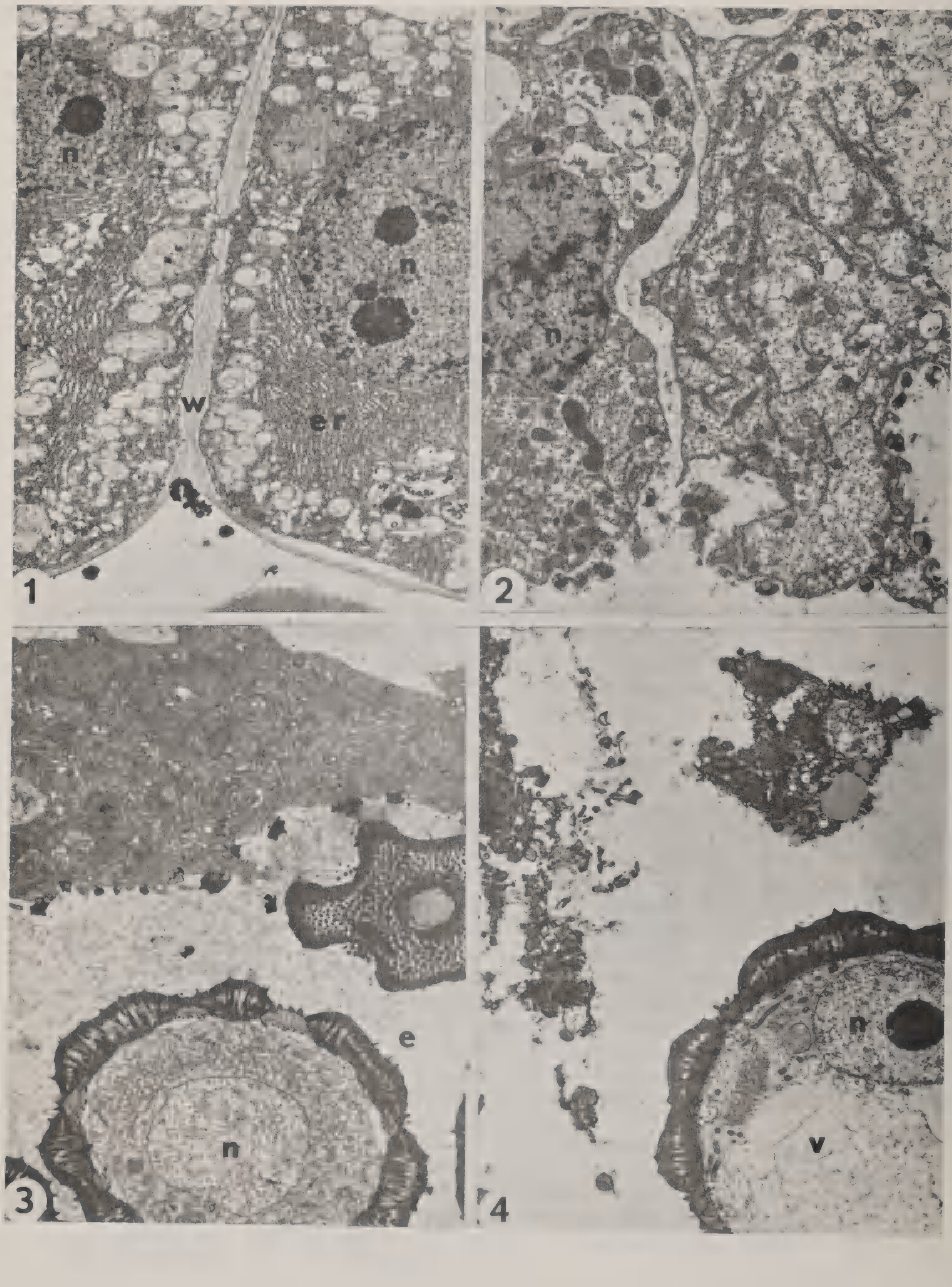
As small vacuoles appear and coalesce to form large vacuoles within the microspore cytoplasm, the tapetal cells of normal anthers degenerate (fig. 4). The cell membrane or plasmalemma becomes disrupted, the cytoplasmic organelles are released into the anther locule and disintegrate; and the tapetal nuclei also degenerate. By the time the microspores undergo mitosis to form the pollen grain with its vegetative and generative cells, the tapetal cytoplasm has disappeared from the anther locule.

In CMS anthers, the tapetal cells show no adverse changes until the end of meiosis, and they are indistinguishable from normal tapetal cells. As soon as the tapetal walls begin to dissolve in CMS anthers, the cells undergo extensive vacuolation (fig. 5). Progressive, rapid degeneration of tapetal cells ensues during the maturation of the tetrads (fig. 6). Normally, tetrad cells first are separated by the callose wall, and then each secretes an individual cellulosic wall (or primexine) which is covered by sporollenin after the microspores are released from the tetrads. By the extent of the primexine, one can distinguish early tetrads from late tetrads. Figure 6 shows late tetrads with well-developed primexine, degenerated tapetal cells, and degenerating tetrad cells. A slightly later stage (fig. 7) shows degenerated tapetal cells and degenerating microspores in tetrads. Further degeneration produces a central mass of collapsed microspores and tapetal cytoplasm and finally the CMS anther itself collapses.

If normal tapetal cell secretion and degeneration provide nutrients for developing microspores, it is easy to see how precocious degeneration of tapetal cells in CMS anthers leads to their collapse. It is apparent that proper timing of tapetal cell degeneration is essential and that premature collapse of tapetal cells leads inevitably to microspore and anther degeneration.

Fig. 1-4. Stages in normal tapetal cell degeneration. All x 5500. Fig. 1. Tapetal cells with walls (w), quantities of endoplasmic reticulum (er), and nuclei (n). Fig. 2. Tapetal cells with walls dissolved, nucleus (n). Fig. 3. Microspore stage, developing exine (e), and tapetal cytoplasm enclosed by plasmolemma. Fig. 4. Vacuolate (v) microspore with nucleus, and degenerated tapetal cytoplasm.

Fig. 7-9. Tapetal cells of CMS anthers. All x 12,400. Fig. 7. Extensive vacuolation (v) of walled (w) tapetal cell with quantities of endoplasmic reticulum (er). Fig. 8. Degenerating tapetal cell cytoplasm (arrow) and tetrad cells separated by callose wall (cw), primexine present (pe). Fig. 9. Degenerated tapetal cell cytoplasm (arrows) and tetrad cell with callose wall (cw) and degenerated cytoplasm (cy).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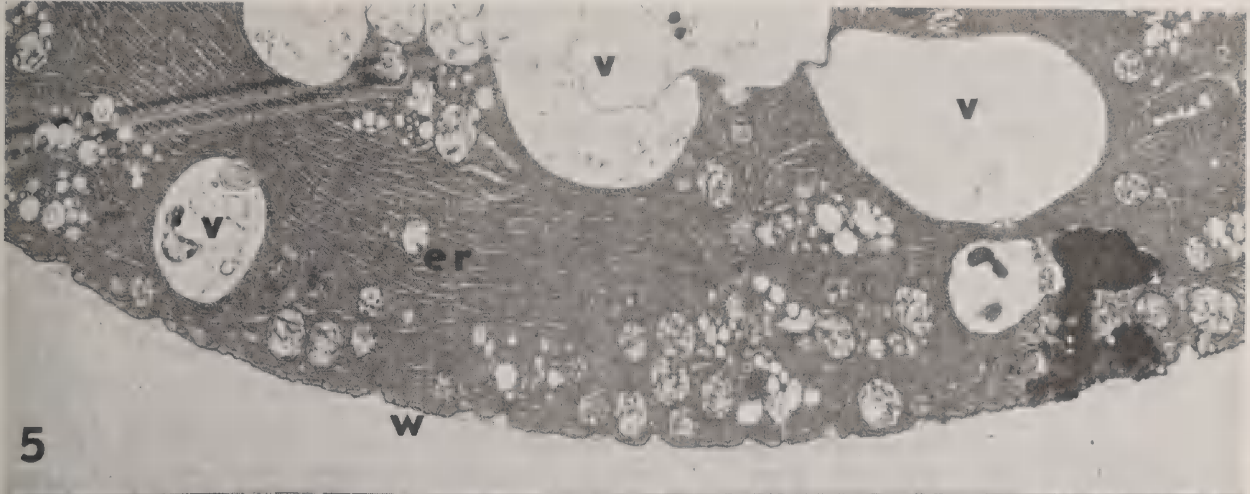
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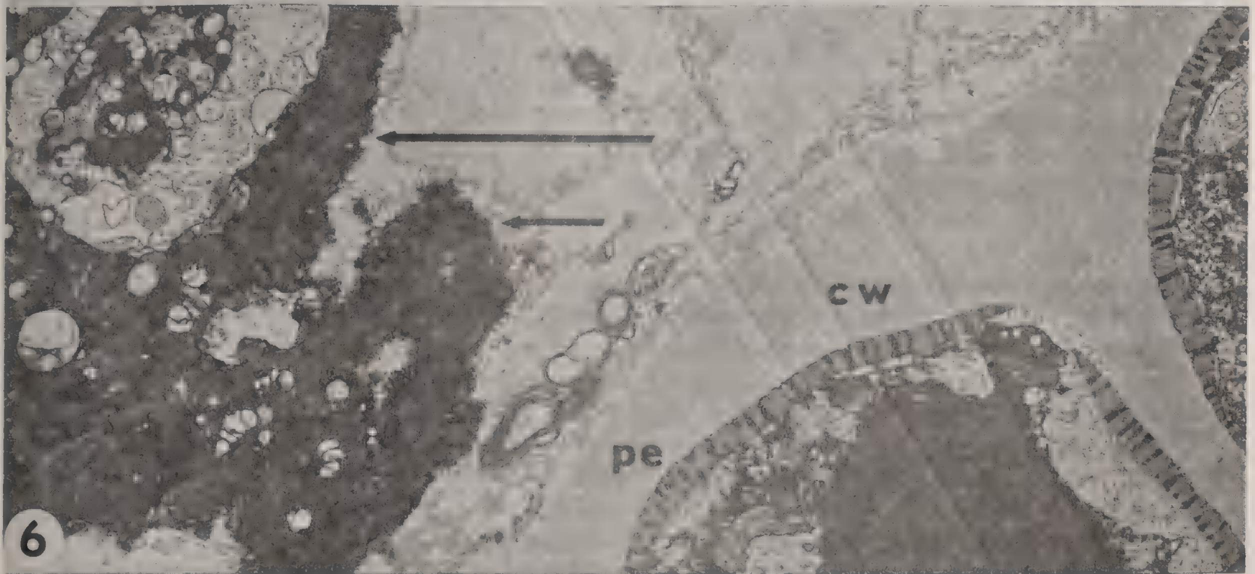
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Bacterial Rot of Sugarbeet

E. D. Whitney

During the late summer and fall of 1971, a rot of sugarbeet of epidemic proportions (30-40%) developed in beets grown in the Lost Hills area of California. Efforts to isolate a fungal pathogen from the infected beets failed. In 1972 a cooperative effort between the USDA, University of California, and the California Sugar Companies was undertaken to investigate the disease.

The disease.--The disease is characterized by vascular necrosis of the crowns, roots, and petioles followed by the development of a wet rot in the crowns and roots. Infected petioles usually exhibit black longitudinal lesions which may split. The crowns may also show splitting. From these openings a black ooze exudes which may show evidences of foaming. In root and crown cross sections the area adjacent to the necrotic vascular bundles turns pink or reddish-brown when exposed to the air for a few minutes. The rot develops slowly with the wet rot stage lasting 3-4 weeks or longer.

The causal organism is a bacterium of the genus *Erwinia* which is related to the organism causing soft-rot of potatoes, carrots, and other vegetables (1).

The effect of the disease on percentage root-rot and yield of selected varieties.--To evaluate the effect of the disease on varieties, four varieties were planted in replicated strips. The varieties S301 H8, US H9A, US H10A, and C-413 were planted in two row plots with two passes through the field. The three hybrids have the same F_1 hybrid parent, 569 H3. The pollen parents of all three hybrids were originally derived from US 22. The pollen parents of US H9A and US H10A were selected for virus yellow resistance and bolting resistance. The pollen parent, A6201 or S301 H8 was selected for bolting resistance only. Of four plantings, rot developed in two. The plots were planted in April and May.

Some rot was observed in the two plots by July 25, 1972, but the differences among varieties were small. However, by August 23 differences became evident. At each harvest date, two 10-foot sections, one from each strip, were randomly selected and the percentage of beets with rot determined (Table 1). Counts were made about every 3 weeks.

Six two-row plots 12.5 ft long from three random locations within the strip planting of each of the two fields were harvested November 21 and weighed. The data were analyzed as randomized complete blocks with 6 replications. The beets were also analyzed for percentage sucrose, ppm amino nitrogen, sodium and potassium. The data are presented in Table 2.

Results of tests by the University of California conducted at Davis, California, showed that infection occurred after inoculation of injured and noninjured large field-grown sugarbeets. However, the percentage of infection was greater in injured plants (1).

To determine if injury was necessary to get infection in greenhouse-grown beets (five weeks old), four varieties, US H9A, US 75, C-413, and 569 H3, were inoculated with a mixed inoculum of isolates SB-4, -6, and -7. The plants were injured by poking one small hole with a dissecting needle in each of four petioles approximately 1 cm from the crown. The plants were then inoculated by atomizing about 1 ml of inoculum into the crown of each plant. Noninjured plants were similarly treated. Three plants from each treatment were placed either in the greenhouse, moist chamber or growth chamber. The humidity in the moist chamber was approximately 100%. The growth chamber was maintained at 28° C and about 90% humidity. Data were recorded 4 weeks after inoculation (Table 3).

A similar test of 10-week old plants placed only in the moist chamber was made. Each variety was replicated six times. Data were collected seven weeks after inoculation (Table 3).

During the selection of C-413 from US 75 for virus yellows resistance, only plants with green hypocotyls were selected. To test the difference in the susceptibility of the parent and the selection and whether green hypocotyls had any effect on susceptibility, these two varieties were tested. Eighteen 4-week old plants of C-413, US 75 with red hypocotyls and US 75 with green hypocotyls were used. The plants were inoculated with a composite inoculum of isolates SB-4, -6, -7, and -13 in equal concentrations (reading of 100 on a Klett-Summerson colorimeter with green filter). The plants were placed in a growth chamber at 28° C, 90% R H and 14 hrs light for the first 20 days and then placed in the greenhouse. Readings were made 1 month after the inoculation. The results are based on a scale of 0 to 2; 0 = healthy, 1 = some infection, 2 = dead (Table 4).

Effect of rot on sugarbeet quality.--Reports from processors indicated that beets with rot in 1971 were difficult to process. Therefore, tests were run to evaluate the effect of rot on beet quality.

Two approaches were used to evaluate the quality of beets with rot. In the first, known weights of rotted and healthy sugarbeets, (USH9A) were mixed. The beets were run through a saw to collect the brei. In the second, paired adjacent beets, one rotted and one healthy, were selected in the field. The single beets were run through a beet rasp to collect the brei and mixed on a weight basis. The brei was analyzed for percentage sucrose, ppm amino nitrogen, sodium and potassium. The data from these tests are presented in Table 5.

Discussion and conclusions.--The isolation of a pathogenic bacterium by Thomson and Schroth (1) from diseased sugarbeets was a major step in the elucidation of this disease of sugarbeet.

The observations that the pollen parent C-413 is highly susceptible to bacterial rot is of great concern due to its invaluable contribution to the control of virus yellows of sugarbeet. However, observations suggest that variation for resistance exists within selections with virus yellows resistance but will require the development of a selection and testing program.

The data indicates that some type of opening to the vascular tissue is necessary for the bacterium to incite disease. These openings could be due to cultural practice which injure the plant or wounds from growth cracks due to rapid growth.

These preliminary results suggest that the F_1 hybrid 569 H3 is more resistant than the pollen parent, C-413.

There does not appear to be any linkage between hypocotyl color and susceptibility to bacterial infection. However, the parent variety US 75 is significantly more resistant than the yellows resistant selection, suggesting a linkage or an inadvertent selection for bacterial susceptibility when virus yellows resistant plants were selected. A linkage, however, would seem unlikely as virus yellows resistance appears to be quantitatively inherited.

Sugarbeet quality is affected by bacterial rot to the greatest extent by the reduction in percentage sucrose. An inverse linear relationship between percentage rot and sucrose occurs. In some cases, tests 2 and 3 (Table 5), an increase in amino nitrogen resulted. These two factors would decrease beet purity and reduce extractable sugar.

One interesting factor which also decreased purity of beets from the Lost Hills area of California was the high sodium content of the beets grown on these desert soils. Sodium content was 5 to 10 times greater than for sugarbeets grown in the Salinas Valley of California.

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Table 1. Susceptibility of Varieties to Bacterial Rot.

	% Rot of Sugarbeet Varieties			
Date	US H9A	US H10A	S301H8	C-413
8/23	11.8	10.0	4.1	14.6
9/12	14.9	10.5	2.1	36.2
9/26	16.1	15.0	8.8	35.5
10/16	12.1	16.1	20.0	52.2
11/21	13.5	15.5	12.9	25.2
$\bar{x}$	13.7	13.4	9.6	32.7

LSD .05 = 8.0

Table 2. Effect of bacterial rot on yield of selected varieties.

Variety[a]	Test	T/A	% Sugar	PPM NH_2-N	PPM Na	PPM K
US H9A	1	33.8	12.9	575	1287	2674
	2	38.8	11.7	660	2006	2769
US H10A	1	32.7	13.6	544	1097	2511
	2	36.9	12.4	667	1871	2780
S301 H8	1	35.7	12.8	625	1455	2553
	2	36.9	11.9	742	2059	2776
C-413	1	26.4	13.3	534	962	2759
	2	26.8	12.2	610	1763	3027

LSD .05 = 3.2 T/A

[a] Yields for these four varieties at Salinas in 1969-70 were 47.4, 46.6, 41.6 and 45.1 T/A, respectively. LSD .05 = 4.1 T/A. (Sugarbeet Research, pg B8-B9, 1970).

Table 3. Effect of Injury on the Susceptibility of Sugarbeet to Bacterial Infection.

	Varieties[a] (5 weeks)[b]				
Treatment	US H9A	US 75	C-413	569H3	
Injury[c]	2/3[d]	1/3	2/3	1/3	Greenhouse
	2/3	2/3	3/3	1/3	Moisture Chamber
	1/3	1/3	2/3	1/3	Growth Chamber
Total	5/9	4/9	7/9	3/9	
		(10 weeks)[b]			
Injury[e]	1/6	1/6	2/6	0/6	Moisture Chamber

[a] US 75 C-413 569H3 US H9A

[b] Age of plant at time of inoculation.

[c] Only one of 36 non-injured plants was infected.

[d] Number dead/number inoculated.

[e] None of the non-injured plants was infected.

Table 4. The Effect of Variety and Hypocotyl Color on Susceptibility to Bacterial Infection.

	Varieties		
	C-413	US 75rr[a]	US 75R-[a]
Rep 1	3[b]	2	2
2	3	1	3
3	5	2	1
4	3	2	2
5	4	3	2
6	4	0	3
Total	22	10	13
$\bar{x}$	3.7	1.7	2.2

LSD .05 = 1.1

[a] rr = green hypocotyls, R = red hypocotyls.

[b] Total of 3 plants/pot.

[c] Rating 0 = healthy, 1 = some infection, and 2 = dead on a single plant basis.

Table 5. Effect of Bacterial Rot on Sugarbeet Quality.

Treatment	0 % Rot: % Sucrose	0 % Rot: PPM NH_2-N	0 % Rot: PPM Na	0 % Rot: PPM K	10 % Rot: % Sucrose	10 % Rot: PPM NH_2-N	10 % Rot: PPM Na	10 % Rot: PPM K	20 % Rot: % Sucrose	20 % Rot: PPM NH_2-N	20 % Rot: PPM Na	20 % Rot: PPM K
Whole Beets	10.3	820	2170	2179	10.2	790	1729	1445	9.3	722	1817	1847
Paired Beets												
Exp 1	10.6	818	2748	2378	9.6	781	2757	2352	8.6	745	2712	2304
2	11.8	824	1517	2539	10.8	843	1540	2558	10.0	881	1548	2512
3	14.5	636	1828	2585	13.2	649	1961	2671	12.0	685	2007	2704

Treatment	40 % Rot: % Sucrose	40 % Rot: PPM NH_2-N	40 % Rot: PPM Na	40 % Rot: PPM K	100 % Rot: % Sucrose	100 % Rot: PPM NH_2-N	100 % Rot: PPM Na	100 % Rot: PPM K	
Whole Beets	7.4	762	1891	1727	1.7	--	2225	1757	N = 5
Paired Beets									
Exp 1	6.7	766	2723	2163	2.0	769	2744	2139	N = 15
2	7.8	954	1481	2492	1.8	1218[a]	1418	2495	N = 27
3	9.8	913	2330	2876	1.8	1004[b]	3042	3019	N = 15

[a] Significant increase in amino nitrogen of rotted beets.

[b] Increase of amino nitrogen significant at the 10% level.

The Effect of Beet Yellow Virus on the Susceptibility of Sugarbeet to *Rhizoctonia solani*

E. D. Whitney

Beet yellows virus (BYV) and *Rhizoctonia solani* Kuehn are important pathogens of beets in some areas of California. Some field observations have suggested that plants infected with BYV are more susceptible to *R. solani* than healthy sugarbeets. To test this possibility the following test was conducted.

Materials and methods.--Three and 7 week old hybrid sugarbeets, 554 H1, were inoculated with strain 5 of BYV by placing viruliferous aphids on each plant for 3 days. The soil of each plant to receive *R. solani* was infested with the fungus by sprinkling 0.1 g of barley-fungus inoculum into each pot of soil. The inoculum was then covered with autoclaved-moist soil. Two isolates of the fungus were used; Rs 18, a damping-off isolate, and Rs 6, a root-rot isolate. Four replications of two plants each for each treatment were used. The treatments were healthy plants, BYV-infected plants, plants grown in fungus-infested soil, and a combination of the two. The fungus was added to the soil 1 and 3 weeks after BYV inoculation for the 3-week old plants and 1 week after for the 7-week old plants.

Results and discussion.--None of the combined fungus-virus treatments appeared to be more destructive than the fungus alone. Neither number of plants killed nor number of days until plant death strongly suggested any increase in the susceptibility of BYV-infected plants to *R. solani* (Table 1). These data suggest that an interaction between the virus and the fungus is not common. However, different strains of the virus or isolates of the fungus may interact to cause a synergistic effect on sugarbeet.

Table 1. Effect of *R. solani* in combination on sugarbeet.

	Isolate R.s. 18				Isolate R.s. 6			
Plant age [a]	R.s.		R.s. and BYV		R.s.		R.s. and BYV	
3 wk/4 wk	4/8[b]	8[c]	6/8	8	8/8	29	8/8	22
3 wk/6 wk	0/8	-	0/8	-	8/8	63	7/8	66
7 wk/8 wk	0/8	-	0/8	-	5/8	71	6/8	73

[a] Plant age at time of BYV inoculation/plant age at time of *R. solani* inoculation.

[b] No. of plants killed/total plants.

[c] Mean age of plant at death, days.

Effects of Fumigation, Fertilizer, Variety and Crop Rotation on Yield, Sucrose and Purity of Sugarbeets

I. O. Skoyen and E. D. Whitney

The concluding year's results are reported of a three-year experiment designed to study the effects of soil fumigation on soil-borne disease organisms, on increasing yield, and the effects on percent sucrose and purity. Reports summarizing experimental procedures and results for the first two years are presented in Sugarbeet Research, 1970 Report, pages B74-B80 and in the 1971 Report, pages B61-B65. All the comparisons that could be made over years for the experiment are not reported because the analyses are not completed.

Materials and Methods: The factorial design for the 1972 phase of the experiment had four levels for crop rotation, three levels for nitrogen and two levels each for fumigation and varieties. A split-split plot field arrangement was also used for the 1972 test. Crop rotations were the main plots, fumigation treatments the sub-plots, and variety-fertilizer combinations sub-sub-plots. All treatments were completely randomized within each of the three blocks and within the sub-plots. Each block was a replication.

Nitrogen (N) fertilizer levels in 1972 were 100, 178 and 264 lbs. per acre (/A). Level one, applied preplant, included 56 lbs. P_2O_5 and 28 lbs. K_2O/A. A sidedress application of 78 lbs. N/A on levels two and three was made eleven weeks after planting and the final application of 86 lbs. of N/A on level three, four weeks later.

The soil fumigation (with 67% methyl bromide--33% chloropicrin), using commercial equipment, was made on February 22, 1972 at a rate of 350 lbs./A. The fumigant was injected 8 inches deep and a plastic tarp was laid over the treated area simultaneously with the injection. Soil temperatures were 53-54° F at the 8-inch depth. The plastic tarp was removed after 3 days.

Test varieties US H7A and US H9B were sown March 24 and thinned May 2-4, 1972.

Frequent irrigations of short duration (by sprinkler system) were used to avoid runoff, to minimize possible contamination of treated strips and as needed to maintain growth.

Plot size was the same as in 1970 and 1971, 4 rows wide by 27' long and with 3' alleys between plots. The two center rows were harvested and the roots weighed and analyzed for percent sucrose,

ppm NH_2 nitrogen (NH_2N), ppm sodium (Na), ppm potassium (K), and impurity index. The test was harvested October 2-3, 1972, approximately six and one-half months after sowing.

Results and Discussion

The test results were analyzed in three sets: (1) all data combined in which history-fumigation levels were combined under treatments, (2) as a three history-two fumigation factorial for the main plots, (3) as a two history-four fumigation factorial for the main plots. The three history-two fumigation factorial analyses (Set 2) is reported because it shows the essential differences that occurred in the 1972 test (Table 1).

Main Effects: There were fewer significant differences between treatments for main effects (Yr, F, Ft and V) than occurred in the 1970 (page B78) and 1971 (page B65) tests. Gross sugar differences were not significant for any test variable or interaction comparisons. However, plots producing four-year-beets had significantly lower tons per acre (TPA) than plots in beets either three years or one year. The latter two had essentially the same root yields. Root yields for fumigated plots were similar to those observed in previous years and outyielded non-fumigated plots significantly, by 3.2 TPA. Responses to nitrogen fertilization for root yield, as in 1970 and 1971, showed highly significant yield increases with successive N applications. Plots receiving 178 lbs./A of N yielded 3.6 TPA more and those receiving 264 lbs./A of N yielded 5.3 TPA more than plots receiving 100 lbs./A of N. As in the past, the gross sugar values and percent sucrose for 264 lbs. of N show that the significant loss in percent sucrose due to excess N are not compensated by increased tonnage. TPA for US H9B was significantly higher than that of US H7A but percent sucrose was equivalent. The optimum N fertilization level for the 1972 test was 178 lbs./A with sucrose percentage averaging only 0.23% point lower than the low level of N.

In 1972, as in 1971, the only differences in ppm NH_2N in the roots occurred in the fertilizer treatments with each increment of N producing significantly higher NH_2N. The ppm Na content in roots of US H7A was significantly higher than that in roots of US H9B. This has occurred over the three years of the test. Significant differences again occurred in all test variables for ppm K in the roots. Roots from first- and third-year-beet plots, from fumigated plots, from US H7A plots, and roots from both the second and third N fertilizer levels each had significantly higher ppm K than that of the corresponding treatments.

There was a significant difference due to replications (blocks) only for percent sucrose in the 1972 test, indicating good test reliability.

Interactions: In 1972 test results, significant interactions occurred in only five of a total of 77 possible associations. This is a marked departure from results for 1970 and 1971. Full interpretation will require examination of the analyses for all data over the years of the experiment. All significant associations were two-factor.

The comparison of years x fumigation (Yr x Fu) showed significant associations (5%) for both sucrose and ppm Na. The difference occurred in fourth-year-beet plots where roots from non-fumigated plots had a mean percent sucrose 1.1 points higher than that in roots from fumigated plots. However, for third- and first-year-beet plots the range in percent sucrose was only about 0.1 and 0.3 respectively between fumigated and non-fumigated plots. It appears that field variability must have contributed to these unusual results although this was not visually apparent. The Yr x Fu interaction for Na was also significant (5%) but of questionable reliability. Na uptake by the roots in fumigated plots (396 ppm) was a mean 158 ppm higher than that in non-fumigated plots (238 ppm) for fourth-year-beets. However, in third-year beets Na uptake was slightly greater in non-fumigated plots (42 ppm) and in first-year-beet plots Na uptake was equal between fumigation treatments.

The questionable results for Na are also reflected in the years x variety (Yr x V) interaction. This was significant (5%) but with an unlikely range between the two varieties for third-year-beets where US H7A showed a mean 128 ppm greater Na uptake than US H9B. Uptake between varieties was nearly equal for both fourth-year and first-year-beets. However, US H7A had the greater uptake in all instances. This interaction was highly significant in both 1970 and 1971. In 1972, fourth-year-beets showed greater Na uptake than first-year-beets although not significantly.

As in previous years, the significant (5%) variety x nitrogen (V x N) interaction again demonstrated the inverse effect of high nitrogen fertilization on percent sucrose and impurity index. Sucrose percentage was highest with the 100 lbs. of N (low level) treatment, was only slightly depressed at the 178 lbs./A treatment and was reduced substantially by the 264 lbs./A (high level) of N. This reduction, with 264 lbs. N/A, compared with the percent sucrose for 100 lbs. of N, was 0.63 percentage points for US H7A and 1.53% for US H9B. US H9B had slightly higher sucrose percentage than US H7A at the low level of N. The mean impurity index for varieties was 573 for the 100 lb. low level of N, 649 for 178 lbs. of N and 761 for the 264 lb. high level of N. US H7A had the higher impurity index at the low level of N and was lower than US H9B at the high level of N and by nearly the same magnitude of difference. The impurity index was the same for both varieties at the middle level (178 lbs.) of N.

It was stated in the 1971 report (B64) that repeated beet cropping had a depressing effect on yield. This relationship is not as sharply defined in the 1972 results. This year, plots in beets for 4 years showed substantially lower root yields than first-year beets, but plots in beets three years had the highest root yield, by a small margin, over first-year-beet plots. This indicates probable field variability. Such factors as damping off, effects of root damaging and/or root rotting fungi showed minor effects during the growing season and were not restricted to any given treatment.

Table 1. Means, significance levels and interactions for the characteristics measured over the four test variables.

Treatments	Levels	df.	Acre Yield: Pounds Gross Sugar	Acre Yield: Tons Beets	Percent Sucrose	PPM: NH_2 N	PPM: Na	PPM: K	Impurity Index
Years (Yr)	69-70-71-72		9,040	28.6	15.94	448	317	1903	655
	70-71-72	2	10,220	32.5	15.73	444	295	2033	674
	72		9,970	31.9	15.71	393	257	2134	652
F value			3.88	4.85*	1.41	3.63	1.87	7.29*	1[d]
Fumigation (F)	Non	1	9,360	29.4	16.04	442	269	1965	645
	Fum 72		10,120	32.6	15.55	415	310	2083	676
F value			4.26	8.35*	16.68**	2.12	2.55	5.66*	1.50
Yr x F		2	1	1	6.18*	1.92	5.47*	1	1
Error A		10							
Variety (V)	US H7A	1	9,508	30.0	15.91	412	316	2108	663
	US H9B		9,973	32.0	15.68	445	263	1940	659
F value			1.26	18.16**	3.21	6.16	8.51**	27.72**	1
Nitrogen (N)	100	2	9,070	28.0	16.23	358	208	1976	572
	178		10,100	31.6	16.00	435	272	2019	649
	264		10,050	33.3	15.15	492	390	2077	761
F value			2.65	43.62**	25.89**	32.99**	34.40**	3.41*	60.16**
Yr x V		2	1	1	1	1	4.35*	1	2.08
F x V		1	1	1.10	1	1	3.75	1	1
Yr x F x V		2	1	1	1	2.28	1	1	[illegible]
Yr x N		4	1	1.33	1	1	1.06	1	1.02
F x N		2	1	2.29	1	1	1	1	1
Yr x F x N		4	1	1	1	1.24	1	1	
V x N		2	1	1	4.13*	1	1	1.21	3.[illegible]*
Yr x V x N		4	1	1	1	1	1.02	1.13	1.12
F x V x N		2	1	2.40	1.01	1	2.55	1	1.41
Yr x F x V x N		4	1	1.17	1	1.67	1.20	1.42	[illegible]
Error B		60							

d = less than one
* = 0.05
** = 0.01

NEMATOLOGY STUDIES

Arnold E. Steele

Results of 1972 tests of nematicides for control of *Heterodera schachtii* on sugarbeet.

A test of 12 treatments was replicated 7 times in a randomized complete-block design on a field of clay loam soil (44% clay, 28% silt, and 28% sand) infested with *Heterodera schachtii*. Nematode counts ranged from 15-45 cysts with viable eggs/100 gm of dried soil. Plots consisted of 4 beds 100 feet long with 2 rows per bed. Telone was applied broadcast at a depth of 8 inches on January 24. Temik 10G was applied below the seed row in 1- or 5-inch bands at a depth of 4 inches on January 25. Mocap 10G and Nemacur 15G were applied below the seed row in 5-inch bands at a depth of 4 inches on January 31. Temik 10G was also applied as a side-dressing between the seed rows at a depth of 4 inches on January 25; on the furrow side of the row and at furrow depth on March 22. The plots were planted to sugarbeet on February 1, sampled to evaluate nematode control and thinned on March 20, and harvested on October 3.

Only Temik 10G at 4 or 6 lb. active/A applied in 1- or 5-inch bands, respectively, significantly reduced populations of sugarbeet nematode on sugarbeet by thinning time. Beets in plots treated with Mocap 10G were stunted. Yields of beets and sugar at harvest were highest from plots treated with 4 lb. active of Temik 10G, applied either in a 1-inch band at planting, or as a side-dressing after thinning.

A second test of 17 treatments was replicated 5 times in a randomized complete-block design in a field of clay loam soil (44% clay, 28% silt, and 28% sand) infested with *Heterodera schachtii*. Nematode counts ranged from 9 to 25 cysts with viable eggs/100 gm of dried soil. Plots consisted of 4 beds 100 feet long with 2 rows per bed. Telone was applied broadcast at a depth of 8 inches on March 23. Mocap 10G, Nemacur 15G, Temik 10G, and Vydate 10G were applied before planting on March 27-29. Vydate 10G was applied in a 1-inch band, 4 inches below the soil surface under the seed row. Mocap 10G and Nemacur 15G were applied in 12-inch bands on the soil surface and incorporated to 4 inches. Temik 10G was applied in 1- or 5-inch bands 4 inches below the soil surface under the seed row, or in 5- or 12-inch bands on the soil surface and incorporated to 4 inches. Temik 10G was also applied as a side-dressing on the furrow side of the row and at furrow depth on March 29 or on June 23. The plots were planted to sugarbeet on April 7 and thinned on June 6. Plant samples were obtained to evaluate nematode control on May 31 and July 26. Yield data were not obtained for this test.

Only Temik 10G applied as a sidedressing at planting significantly increased growth of sugarbeet by thinning time. These treatments also appeared to give the best control of sugarbeet nematode, and control was still evident more than 3 months after application. However, sidedressings of 2 or 4 lb active/A of Temik 10G after thinning resulted in decreased populations of sugarbeet nematode in plants sampled 33 days after application and 110 days after planting. Mocap 10G stunted growth of sugarbeet and failed to control the sugarbeet nematode, whereas Telone, Nemacur 15G, or Vydate 10G gave good control.

Information on nematicides evaluated:

1) Mocap 10G* - (Prophos) *O*-Ethyl S,S-dipropylphosphorodithioate.
   Mobile Chemical Co., Richmond, Virginia.

2) Nemacur 15G* - (Bayer 68,138) Ethyl 4-(methylthio)-*m*-tolyl isopropylphosphoramidate.
   Chemagro Corp., Kansas City, Kansas.

3) Telone* - 1,3-Dichloropropene and related chlorinated C_3 hydrocarbons.
   Dow Chemical Co., Midland, Michigan.

4) Temik 10G* - (Aldicarb) 2-Methyl-2-(methylthio)proprionaldehyde O-methylcarbamoyl oxime.
   Union Carbide Corp., Salinas, California.

5) Vydate 10G* - (DPX 1410) S-methyl 1-(demethyl carbamoyl)-N-(methylcarbamoyl)osy
   E.I. duPont de Nemours and Co., Wilmington, Delaware.

* Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture and does not imply its approval to the exclusion of other products that may also be suitable.

Cooperators: Larry R. Hodges, Union Carbide Corp., and George W. Wheatley, Spreckels Division of Amstar Corp.

Table 1. Influence of nematicides on control of the sugarbeet nematode and yields of sugarbeet.

Treatment and Rate/A (Active)	Mean No. plants/ 20 foot of row	Mean wt/plant (grams)	Mean nemas per plant	Nemas per gram of root	Mean wt/beet at harvest (grams)	Tons per acre of beets	Mean percent sucrose	Tons sugar/ acre
*Temik 10G 2 lb. 1" band	25.3 1/	11.81 2/	7.56 2/	10.0 2/	593.45 3/	24.18 3/	16.4 3/	3.99 3/
*Temik 10G 4 lb. 1" band	27.9	11.30	3.27 b	4.6	735.28 a	31.11 a	16.1	4.95 a
*Temik 10G 2 lb. 5" band	18.7	13.44 a	4.53	5.4	630.78	23.98	16.1	4.15
*Temik 10G 4 lb. 5" band	18.6	11.79	4.54	6.5	694.23	27.05	16.0	4.33
*Temik 10G 6 lb. 5" band	24.1	12.02	3.77 b	4.4	746.48 a	28.04	16.0	4.85 a
*Temik 10G 4 lb. sidedressing 4/	34.3	12.57	10.43	12.6	675.56	25.09	16.0	4.30
*Temik 10G 2 lb. sidedressing 5/	25.6	11.33	9.91	11.6	750.21 a	28.43	15.9	4.87 a
*Temik 10G 4 lb. sidedressing 5/	30.7	11.26	11.53	16.3	944.29 a	32.48 a	16.2	5.96 a
*Mocap 10G 4 lb. 5" band	20.7	7.61 b	8.99	20.1 a	649.44	24.38	15.8	3.83
*Nemacur 15G 4 lb. 5" band	23.9	9.83	11.19	16.7	623.31	25.42	15.9	4.03
*Telone 20 gal/A broadcast	25.4	12.25	7.84	9.2	544.93	23.26	16.2	3.77
Check (none)	26.6	10.52	9.23	12.0	522.54	23.79	15.5	3.61

1/ Stand counts taken 42 days after planting and before thinning.

2/ Data are from 10 plants sampled 49 days after planting. Lower-case letters designate significantly higher (a) or lower (b) than checks at the 5% level.

3/ Data obtained at harvest, 35 weeks after planting, from 7 replications (plots), each consisting of 2 rows (one bed) 10 feet long.

4/ Applied as a pre-plant sidedressing.

5/ Applied as a post-plant sidedressing after plant samples were obtained for nematode evaluations.

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Table 2. Influence of nematicides on control of the sugarbeet nematode.

Treatment and Rate/A (Active)	Mean No. plants/ 20 foot of row	Mean wt/plant (grams)1/	Mean nemas per plant1/	Nemas per gram of root1/	Mean wt/plant (grams)2/	Mean nemas per plant2/
*Vydate 10G 4 lb. 1" band	37.2	34.25	18.72 b	4.5 b	-	-
*Mocap 10G 4 lb. 12" band	41.8	21.78	75.44	22.2 a	-	-
*Mocap 10G 6 lb. 12" band	36.7	22.17	46.74	15.3	-	-
*Nemacur 15G 4 lb. 12" band	42.9	32.21	26.58 b	5.6 b	-	-
*Nemacur 15G 6 lb. 12" band	43.5	29.56	41.70	9.9	-	-
*Telone 10 g/A broadcast 8"	34.0	33.91	27.06 b	5.4 b	-	-
*Temik 10G 4 lb. 1" band	37.2	33.83	12.86 b	2.6 b	-	-
*Temik 10G 4 lb. 5" band (incorp.)	43.7	22.9	38.9	7.9	-	-
*Temik 10G 4 lb. 5" band	34.2	28.7	33.1 b	10.5	-	-
*Temik 10G 4 lb. 12" band	39.9	24.92	29.20 b	10.4	-	-
*Temik 10G 3 lb. sidedressing3/	34.2	49.62 a	9.56 b	1.6 b	-	-
*Temik 10G 4 lb. sidedressing3/	33.3	46.13 a	7.48 b	1.3 b	-	-
*Temik 10G 2 lb. 5" band + 2 lb. sidedressing4/	33.2	25.99	33.80 b	9.4	55.5	208.5 b
*Temik 10G 4 lb. 5" band + 2 lb. sidedressing4/	38.9	28.14	20.68	4.7 b	64.4	392.3 b
*Temik 10G 2 lb. sidedressing4/	31.0	27.93	29.10 b	6.6	53.2	193.5 b
*Temik 10G 4 lb. sidedressing4/	28.0	31.27	42.96	11.2	38.4	55.9 b
Check (none)	30.5	25.88	52.07	13.9	55.8	1,708.1

1/ Data from beets sampled 54 days after planting. Lower-case letters designate significantly higher (a) or lower (b) than checks at the 5% level.

2/ Data from beets sampled 110 days after planting.

3/ Applied as a pre-plant sidedressing.

4/ Applied as a post-plant sidedressing after the first samples were obtained for nematode evaluations.

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The effects of pretreatment with nematicides on hatching and emergence of larvae from cysts of the sugarbeet nematode

In three separate tests water solutions of several nematicides (Tables 3, 4 and 5) were tested for lethal affects to embryonated larvae of the sugarbeet nematode, Heterodera schachtii. Cysts obtained from infected plants grown in a greenhouse were treated one week with nematicide solutions at room temperatures, after which the cysts were removed from the chemical solutions, and placed in several changes of tap water during a period of 4 days. The cysts were then placed in sugarbeet root diffusate for 4 weeks to stimulate hatching and emergence of larvae as a means of assessing the nematicidal effects of the chemical treatments. Counts of emerged larvae (Tables 3, 4 and 5) were analyzed for statistical significance.

None of the chemical treatments completely suppressed hatching of sugarbeet nematode larvae. Only cysts treated with 100-1000 ppm Nemacur or 100 ppm Aldicarb sulfone showed appreciable reductions in larval hatches. The data indicate that under these conditions Nemacure is an effective contact ovicide and that if the other tested materials are effective nematicides they must act against hatched larvae in the soil or in plants.

Cooperator: Larry Hodges, Union Carbide Corp., Salinas, California.

Table 3. Emergence of larvae from cysts of *Heterodera schachtii* treated 1 week in chemicals, 4 days in water and 4 weeks in sugarbeet root diffusate.

Treatment Chemical	Concentration (ppm)	No. larvae in chem	No. larvae in water	No. larvae in diffusate replication 1	2	3	4	Total	Mean [2/]
Check	-	663	20	1370[1/]	1978	2738	2689	8775	2193.8
Prophos	100	57	144	2304	2953	3221	2958	11436	2859.0
	200	40	88	3188	2698	5127	3543	14556	3639.0
	500	19	19	2826	2212	3001	2028	10067	2516.8
	1000	2	3	1663	1745	2159	1200	6767	1691.8
Vidate	100	12	209	2042	2796	3915	3359	12112	3025.5
	250	1	164	2313	2484	2695	2639	10131	2532.8
	500	1	14	3264	4109	2998	3675	14046	3508.8
	1000	6	8	2489	2812	3237	3291	11829	2957.3
	2000	3	2	1796	3807	1836	1867	9306	2326.5
PP 156	100	4	237	3775	3950	2954	3025	13704	3426.0
	200	2	26	2885	2618	3014	2723	11240	2810.0
	500	9	34	2632	2823	2410	2763	10628	2657.0
	1000	0	56	974	2707	2574	3240	9495	2373.8
Nemacur	100	5	1	15	3	24	18	60	15.0
	200	7	0	1	28	6	6	41	10.3
	500	3	0	1	23	12	0	36	9.3
	1000	0	0	2	0	1	1	4	1.0

1/ Number of larvae emerged from 20 cysts in sugarbeet root diffusate. Data for check includes larvae emerged in water and diffusate.

2/ Differences between means highly significant. LSD .05 = 736.5

Table 4. Emergence of larvae from cysts of *Heterodera schachtii* treated 1 week in chemicals, 4 days in water and 4 weeks in sugarbeet root diffusate.

Treatment Chemical	Concen-tration (ppm)	No. larvae in chem	No. larvae in water	No. larvae in diffusate replication 1	2	3	4	Total	Mean[2/]
Check	-	-	-	1046[1/]	807	1431	1612	4896	1224.0
Aldicarb	100	24	0	2011	1648	2572	1646	7877	1969.2
	200	2	0	2321	2085	2377	2002	8785	2196.3
	500	20	0	2679	1874	2479	2213	9245	2311.3
	1,000	8	0	1926	1544	505	1734	5709	1427.3
Aldicarb Sulfoxide	100	5	3	1938	2264	1277	2208	7687	1921.8
	200	3	0	2380	2369	1828	2011	8588	2147.0
	500	13	0	754	1812	1424	1244	5234	1308.5
	1,000	8	0	974	1977	2101	1322	6374	1593.5
Aldicarb Sulfone	100	15	35	1972	2034	2051	2623	8680	2170.0
	200	25	70	1726	1233	2665	3429	9053	2263.3
	500	2	25	2124	3436	1673	1577	8810	2202.5
	1,000	0	0	2476	2696	2518	2354	10044	2511.0

1/ Number of larvae emerged from 20 cysts in sugarbeet root diffusate. Data for check includes larvae emerged in water and diffusate.

2/ Differences between means highly significant. LSD .05 = 763.7

Table 5. Emergence of larvae from cysts of Heterodera schachtii treated 1 week in chemicals, 4 days in water and 4 weeks in sugarbeet root diffusate.

Treatment Chemical	Concentration (ppm)	No. larvae in chem	No. larvae in water	No. larvae in diffusate replication 1	2	3	4	Total	Mean [2/]
Check	-	-	-	1791 [1/]	2671	4341	3902	12705	3176.3
Aldicarb	1	519	877	2358	2052	3258	2329	9997	2499.3
	10	38	29	2444	3454	3278	2718	11894	2973.5
	50	19	1	3507	3159	1846	2972	11484	2871.0
	100	18	1	1593	1915	3220	1519	8247	2061.8
Aldicarb Sulfoxide	1	2222	230	1525	1237	1840	1329	5931	1482.8
	10	40	486	2216	2712	1436	1495	7859	1964.8
	50	61	799	990	529	3245	1805	6569	1642.3
	100	10	197	3129	2778	3483	2951	12341	3085.3
Aldicarb Sulfone	1	3044	181	845	705	2710	1836	6096	1524.0
	10	1022	465	1392	2737	771	656	5556	1389.0
	50	38	709	2365	1255	948	2279	6847	1711.8
	100	9	6	93	804	79	83	1059	264.8

1/ Number of larvae emerged from 20 cysts in sugarbeet root diffusate. Data for check includes larvae emerged in water and diffusate.

2/ Differences between means highly significant. LSD .05 = 1083.5

The influence of in vitro chemical treatments on development of larvae of the sugarbeet nematode on sugarbeet.

Second stage infective larvae of Heterodera schachtii were stimulated to hatch and emerge from cysts by treatment with sugarbeet root diffusate. Water solutions of Aldicarb, Aldicarb sulfoxide and Aldicarb sulfone were prepared in concentration of 5, 10, 25, 50 and 100 parts per million (ppm). Nematode larvae were washed free of diffusate and placed in the various Aldicarb solutions for a period of 20 hours after which the larvae were removed from the chemical solutions and washed several times in large volumes of aerated distilled water. The treated larvae were inoculated to newly transplanted seedlings of sugarbeet at the rate of about 60 larvae per plant. Each treatment was replicated 5 times.

After the sugarbeets had grown 32 days in a greenhouse, the plants were taken to the laboratory where the roots and soil were washed and examined for mature female sugarbeet nematode. Data listed in Table 6 were analyzed for statistical significance by the ANOVA method.

Treatment of second stage larvae 20 hours with water solutions of Aldicarb or Aldicarb sulfoxide significantly reduced the numbers of larvae developing to maturity on roots of sugarbeet. Similar treatments with solutions of Aldicarb sulfone appeared to have little or no effect on survival and development of the nematode.

Table 6. Influence of chemical treatments of second-stage larvae for 24 hours on subsequent development of *Heterodera schachtii* on sugarbeet.

Treatment Chemical	Concentration (ppm)	replication 1	2	3	4	5	Total	Mean [2/]
Check	-	33	26	52	43	56	210	42.0
Aldicarb	5	13	18	25	19	10	85	17.0
	10	0	6	1	3	4	14	2.8
	25	18	2	3	5	13	41	8.2
	50	5	2	4	4	0	15	3.0
	100	13	5	8	14	4	44	8.8
Aldicarb Sulfoxide	5	26	18	41	24	23	132	26.4
	10	20	25	26	14	0	85	17.0
	25	17	17	13	23	10	80	16.0
	50	27	16	44	14	12	113	22.6
	100	23	34	10	19	15	101	20.2
Aldicarb Sulfone	5	20	64	49	29	40	202	40.4
	10	33	42	27	40	18	160	32.0
	25	45	34	71	16	25	191	38.2
	50	12	30	34	57	47	180	36.0
	100	30	18	31	42	31	152	30.4

1/ Number of mature females per plant.

2/ Differences between means highly significant. LSD .05 = 13.9

Invasion of non-host plant roots by larvae of the sugarbeet nematode, Heterodera schachtii

A study by Steele showed that females of the sugarbeet nematode (Heterodera schachtii Schmidt 1871) developed to maturity and reproduced on 73 plant species. Of 17 species given an infection index rating of less than 1.0, only one or two females were observed on individual plants of these species.

Reports indicate that larvae of the sugarbeet nematode invade but do not develop to maturity in roots of Phaseolus vulgaris L. (navy bean), Lactuca sativa L. (lettuce), Hesperis matronalis L., Beta procumbens CHR-Smidt., B. patellaris Moq. and B. webbiana Moq. However, Steele and Savitsky later reported that single females developed on two plants of B. patellaris. These findings suggest that many other non-host plants may be invaded by sugarbeet nematode larvae. To test this hypothesis, several non-host plants were selected at random and tested to determine which, if any, were invaded by sugarbeet nematode larvae.

MATERIALS AND METHODS

Six non-host plant species and a susceptible sugarbeet variety were tested in this study and are listed in Table 7. Seed of each species were germinated in sterilized sand. Twenty-five seedlings in the cotyledon stage were transplanted to individual aluminum-foil cylinders, filled with soil heavily infested with cysts containing eggs and larvae of H. schachtii, and grown in a greenhouse. Five plants of each species were removed from infested soil, 15, 30, or 45 days after transplanting. The roots of each plants were washed, weighed, and stained in lactophenol-acid fuchsin, and examined for sugarbeet nematode larvae. The root systems of 10 plants of each species were examined for mature sugarbeet nematode females after the plants had grown 60 days in infested soil.

RESULTS AND DISCUSSION

Sugarbeet nematode larvae were found within roots of all plant species grown 30 or 45 days in nematode infested soil. (Tables 7 and 8). Sunflower was the only test plant grown 15 days in infested soil which was not invaded by larvae. However, roots of sunflower were large when transplanted and the roots and soil may not have had sufficient contact to insure adequate exposure to larvae during the first few weeks of the test.

The observation that all of the 'non-host' plant species were invaded by relatively large numbers of larvae strongly suggests that under field conditions many other non-hosts may also be invaded by the sugarbeet nematode. Association of nematodes with other pathogenic microorganisms in the initiation and intensification of plant diseases have been well documented. Results

of the present test raise the possibility therefore that nematodes may have a broader role in the predisposition of plant diseases, even in non-host plants, than previously suspected.

Mature females with developing eggs were found on at least one plant in each of three species within different families. Since these species were selected at random for testing, many of the species thought to be immune may in fact be only highly resistant to _H. schachtii_. Such occasional development of the sugarbeet nematode on highly resistant species could, and perhaps does, maintain localized areas of low level infestations, which become detectable only after continuous cropping of susceptible host plants. On the other hand, truly immune plants, when used in rotations, may not be exerting simply a neutral effect on the nematodes. Instead, such species might actually reduce the nematode population at much greater than the normal decline rate by having a trap-crop effect.

Table 7. Plants tested for susceptibility to invasion by _H. schachtii_ larvae

Common name	Commercial variety	Scientific name	Family
Sunflower		_Helianthus spp._	Compositae
Morning glory	Candy pink	_Ipomea sp._	Convolvulaceae
Parsley	Plain leaved	_Petroselinum hortense crispum_	Umbelliferae
Egg plant	New York Improved	_Solanum melongena_	Solanaceae
Celeriac	Smooth Prague	_Apium graveolens_ var. rapaceum	Umbelliferae
Sweet Pea	Giant winter-flowering Spencer	_Lathryus odoratus_ L.	Leguminosae
Sugarbeet	Var. US 75	_Beta vulgaris_ L.	Chenopodiaceae

Table 8. Numbers of larvae and adult female <u>Heterodera schachtii</u> recovered from various crop plants grown in infested soil.

Plant	No. Days Plants Grown In Infested Soil	Number plants examined	Total weight of roots (gms)	Number plants infected	Total number larvae recovered	Average number larvae per plant	Average number larvae per gm root	Total number mature females
Sunflower	15	5	5.75	0	0	0	0	0
	30	5	22.45	5	166	33.5	7.4	0
	45	5	28.50	5	135	27.0	4.7	0
	60	10	--	2	--	--	--	2
Morning glory	15	5	2.35	1	8	1.6	3.4	0
	30	5	6.15	4	84	16.8	1.4	0
	45	5	24.10	3	38	7.6	0.3	1
	60	10	--	0	--	--	--	0
Parsley	15	5	0.30	3	68	13.6	226.7	0
	30	5	3.85	5	859	171.8	223.1	0
	45	5	10.30	5	849	169.8	82.4	0
	60	10	--	0	--	--	--	0
Egg plant	15	5	0.30	1	2	0.4	0.7	0
	30	5	3.97	5	804	160.8	202.6	0
	45	5	15.70	5	1,246	249.2	79.4	0
	60	10	--	1	--	--	--	1
Celeriac	15	5	0.10	3	6	1.2	60.0	0
	30	5	1.00	5	176	35.2	17.6	0
	45	5	3.90	5	228	45.6	58.5	0
	60	10	--	0	--	--	--	0
Sweet pea	15	5	2.70	4	296	59.2	109.6	0
	30	5	5.45	5	2,328	465.6	427.2	0
	45	5	10.80	5	3,605	721.0	333.8	0
	60	10	--	0	--	--	--	0
Sugar beet	15	5	0.80	5	1,950	390.0	9,187.5	0

[illegible]

SUGARBEET RESEARCH

1972 Report

Section C

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Logan, Utah - 1972

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Variety Trials

Tests 1 and 2 Forty-six single crosses derived from crossing six selected inbred pollinators with cytoplasmic male-sterile lines and five check varieties were evaluated at Farmington and Logan. Inbred pollinators 0529 and 0532 showed evidence of general combining ability for yield. Inbreds 0529 and 0528 showed good combining ability for sugar percentage; however, the latter was low in yield.

Tests 3 and 4 Single crosses and 3-way hybrids giving good performance in 1971, half-sib hybrids of these crosses and check varieties were evaluated at Farmington and Logan. Variety X year interaction was significant. Hybrids with L-37 as a pollinator showed excellent combining ability for yield and those with L-19 as a pollinator had high combining ability for sugar percentage.

Test 5 Five new lines were tested for general combining ability. The five lines varied in their degree of heterozygosity. They yielded equal to two commercial hybrids, but were generally poorer in quality. One line was selected as being superior in combining ability and will be used in future breeding and selection programs.

Test 6 Thirteen new triploids involving C562 (4N) were evaluated with single crosses involving the same 2N lines. Triploid hybrids of C562 (4N) X 129, or X AI-12 gave higher yield than the reciprocal crosses. With one exception, the 2N lines had higher yield in at least one single-cross combination than they did in their triploid hybrid combinations.

Test 7 One-month old and 2-week old sugarbeet seedlings were transplanted and compared with direct seeded plots for 5 varieties. The 2-week old transplants averaged higher yield and the month-old transplants had the highest sugar percentage. Variety X planting interactions were significant.

Selection Studies

Competition in selection

The effect of competition on individual plant selection was investigated. Two uniform lines (one inbred and one hybrid) were planted alternately with 4 segregating lines at 4, 12, and 24-inch

spacings. Competitive abilities, competitive influences, genotypic variances and genotypic competitional variances were measured. Lines differed in their competitive effects as well as their variances. Competitive ability and competitive influence were not always correlated. Lines with high competitive ability and low competitive influence should be superior in yield in pure-stand plantings. These data indicate that sufficient variation exists, such that progress could be made by selecting in those lines with large genotypic competitional variances.

Specific gravity selection for high sugar percentage

In 1971 competitive beets of heterozygous varieties 9229 and 629 were separated by salt solution into three specific gravity classes. Selfed and crossed progenies were evaluated when beets were topped in a regular manner and when they were topped with a cone-like crown. Findings demonstrated that selection for high sugar percentage could be made by this specific gravity method regardless of the way the beets were topped.

Genetic Studies

Linkage studies of genetic characters in Beta vulgaris L.

a. Annual pollen restorer (Rf). There was no indication of linkage between the Rf gene and red hypocotyl, trout leaf, monogerm seed and virescens.

b. Yellow leaf mutant (yl). This mutant was found to be governed by a single recessive gene. No linkage association was observed with this mutant with monogerm seed or annualness characters.

New sources of male sterility

Eight new sources of male sterility were crossed with O-type and restorer-type pollinators in an effort to identify new sources of cytoplasmic male sterility. One male sterile segregated such as to indicate the sterility is of the genetic type. The A3900-132 source may be different from the cytoplasmic male-sterile source commonly used in the production of hybrids today since it produced mostly male-sterile offspring when crossed with the 201 pollen-restorer inbred. Other sources appeared to be no different than the cytoplasmic male-sterile source now in use.

Continued studies of partial male fertility

Segregation in F_2 progenies of three populations of partial-fertile plants from a single source gave partial-fertile and male-

sterile, but no fertile segregates. Segregation gave a good fit to a 7 PF: 9 MS or a 27 PF: 37 MS ratio, which would suggest partial fertility was governed by 2 or 3 complementary genes. Male-sterile segregates from these populations crossed with the annual tester SLC 03 gave mostly male-sterile plants. However, five lines had 1 to 3 partial-fertile segregates.

The effect of sterile cytoplasm on curly top disease resistance

A greenhouse test and two field experiments were conducted in 1971-72 to study the possible effect of sterile cytoplasm on curly top disease resistance. The comparisons were very similar for the male-sterile and equivalent pollinator inbreds. The data substantiate that there is no association of curly top disease resistance with sterile cytoplasm in the beet.

Physiological Genetics

A follow-up experiment on mitochondrial complementation substantiated last year's findings. Some crosses showed complementation and there was a tendency for complementation to be associated with heterosis; however, this relationship was small and of insufficient magnitude to be of value to the plant breeder. We are not recommending it as a breeding tool.

The mitochondrial efficiency of two hybrids and their inbred parents was measured at bi-weekly intervals throughout the growing season. The hybrids were generally more efficient than their inbred parents; however, these differences were not significant. Significant differences in mitochondrial efficiency were obtained by summing over all measurements. The efficiency ratings (ADP:O ratios) were in the same order as the line's respective field yields. Correlations of ADP:O ratio (mitochondrial efficiency) with growth rate data taken at the same bi-weekly intervals gave highly significant relationships. It was concluded that mitochondrial efficiency is one of the major factors affecting growth rate from early July through mid-October.

A study of peroxidase and esterase isozymes in anthers of normal and cytoplasmic male-sterile plants and CMS lines segregating for the restorer gene (Rf) revealed an esterase isozyme (E_3) that appears to be closely linked to the restorer gene (1.5% crossing over).

Peroxidase and esterase isozyme patterns have been studied in the leaves, petiole and roots of two hybrids and their inbreds throughout the growing season. These patterns differ in the different tissue and change with growth and maturity.

Plant Physiology

Purification of a neutral invertase from sugarbeet roots

Neutral invertase activity was detected in fresh and stored roots. This enzyme has now been purified to a pure protein and some of its biochemical properties determined. In preliminary studies, the activity of this enzyme showed a good correlation with the reducing sugar content of stored roots.

Emergence as an index of growth rate

Greenhouse studies showed that those seedlings which emerge first, maintain the fastest growth rate. Field studies were conducted which confirmed these findings. Plots thinned to plants which emerged first, outyielded those thinned to plants which emerged last, by 44%.

Plant Pathology

Eighteen-hundred rows of sugarbeet breeding lines were evaluated for resistance to curly top virus. Procedures have been developed for inducing curly top epidemics in field plots. These procedures have been successfully employed for 2 successive years.

A survey of sugarbeet fields in Idaho, Washington and Oregon indicated virus diseases were unusually mild. No isolates of curly top virus were found that were as virulent as Utah isolate 66-10.

Progress has been made in identifying methods for purifying curly top virus. Preparations suitable for electron microscopy have now been obtained.

Variety Tests, Logan and Farmington, Utah, 1972

J. C. Theurer, D. L. Doney,
G. K. Ryser, and R. E. Wyse

SOIL TYPES: North Farm: Silty loam. Farmington Farm: Sandy loam.

PREVIOUS CROPS: North Farm: 1971 - fallow except for cereal grains in the east section, 1969-70 alfalfa.

Farmington Farm: 1971 - tomatoes and potatoes
1970 - fallow except for vegetables in the center section of the area

FERTILIZER: North Farm: 640 pounds per acre of 16-20-0.

Farmington Farm: " " " "

PLANTING DATES: North Farm: May 10, 1972. Farmington Farm: April 27, 1972 (all tests at both farms were planted in 2-row plots 37 feet long)

THINNING DATES: North Farm: June 21-25, 1972. Farmington Farm: May 29, 30, 1972.

IRRIGATIONS: North Farm: sprinkled after planting, after thinning, and on a weekly schedule until 2 weeks before harvest.

Farmington Farm: furrow irrigated as needed to keep the field on the damp side throughout the season (approximately weekly intervals) until 2 weeks before harvest.

HARVEST DATES AND PROCEDURES: North Farm: October 16-19, 25, 1972

Farmington Farm: October 2-4, 1972

Tops were removed with a rotobeater and scalped with tractor-mounted scalping tools supplemented by long-handled hoe trimming to assure a complete topping job. Beets in plots were counted when put into the weighing basket on the harvester. A 10-beet sample was taken at random from the harvester table from each row of the 2-row plots for sugar analysis, and all beets in the plot were weighed to determine root yield.

TESTS 1 and 2

Evaluation of New Experimental Hybrids

Forty-six single crosses derived from crossing six selected inbred pollinators with a group of cytoplasmic male-sterile lines were evaluated at Farmington (Test 1) and Logan (Test 2), Utah. US 22/2, two commercial hybrids from Utah-Idaho Sugar Company, and two from Amalgamated Sugar Company were included as check varieties. The 51 entries were planted in 2-row plots in 5 replications of a random block design at each location.

Hybrids with the pollinator 0530 had a high percentage of bolters at both field locations. Thus, performance of this inbred in these hybrid combinations could not be accurately evaluated. This inbred was in the S_4 generation and was originally derived from SLC 128 aa X an Ovana selection. The bolting problem was possibly due to a mix-up in seed lots, since earlier generations of the inbred were good biennials.

The acre yield, sugar percentage and non-sucrose constituents of these hybrids at Farmington are shown in Table 1. Inbreds 0529 and 0532 crossed to non-related CMS lines yielded the highest gross sugar. A7113 X 0529, the highest yielding variety, was significantly better than all but one of the five checks. Thirty-one of the hybrids and all commercial varieties produced greater gross sugar than US 22/2.

Specific combining ability was noted for tons of beets. Inbreds 0529 and 0532 showed some evidence of general combining ability for tonnage. Lines 0528 and 0530 were poor in general combining ability for this character. F.C. 506 CMS X 0529 and 128 CMS X 0529 had the highest sugar percentage. Both 0529 and 0528 inbreds showed good combining ability for this character. No one single cross significantly exceeded the best check for sugar percentage.

All of the crosses with 0532 had a higher impurity index than the mean of the test. This was primarily due to the high nitrogen and potassium content of these hybrids. Crosses with 0528 and 0530 inbreds were lower in impurity index than the mean. These inbreds showed a similar relationship for low ppm, amino nitrogen and potassium.

The performance of these hybrids at Logan is given in Table 2. Inbred 0532 again showed high general combining ability for gross sugar and tonnage. Hybrid A7113 X 0532 which was second highest at Farmington was the highest yielding entry at Logan. This hybrid was significantly better for gross sugar than all but four entries in the test. UI Hybrid D was again the best check variety, but there were five experimental hybrids that were significantly higher in yield compared with other entries. Hybrids having 0529 as a parent were not as high in yield at Logan as they were at Farmington.

For sugar percentage, 0529 and 0528 again showed high general combining ability. This could be expected in the case of 0529, since L-19, which has high general combining ability for sugar percentage, is one of the parents of this line. As expected, 0530 hybrids were low in sugar percentage. Entries with 0532 and 0541 as parents were highest in impurity index values, while hybrids with the 0530 parent had low impurity index values. There was no significance for amino N at this location.

Inbreds 0532 and 0529 show promise for increasing yield and 0529 and 0528 for increasing sugar percentage, when used as pollen parents in hybrids. The greatest deficiency of 0532 is its extremely high impurity index, while low combining ability for tonnage is a marked deficiency of inbred 0528.

TESTS 3 and 4

Single-cross and 3-way hybrids showing highest yield and sugar percentage in 1971 (Logan, Test 7) were evaluated again this year at Farmington (Test 3) and at Logan (Test 4), Utah. Half-sib hybrids not in the 1971 test but with the same pollinators, and hybrids with L-19 were also included in the test. US 22/2, two commercial varieties supplied by Amalgamated Sugar Company and six hybrids supplied by Utah-Idaho Sugar Company were included as checks. In addition, a special nematode selection, AN 014-1, was included in the test at Logan. The 45 entries at Farmington and the 46 entries at Logan were each planted in 2-row plots and replicated 6 times.

Performance at Farmington is shown in Table 3. UI Hybrid #G yielded the highest gross sugar, but this entry was not significantly better than all other check varieties and 11 experimental hybrids in the test. Codes 302, 316 and 310 were highest in gross sugar at Logan in 1971. Only Code 310 remained among the high yielding entries this year. Crosses with L-37 as a pollinator demonstrated good general and specific combining ability for yield. Entries having L-19 as a pollinator were highest in sugar percentage, as would be expected based on previous year's data.

Inbred pollinators 7584, 29.008, 7594, and 0461 S (246) showed little promise for future use in hybrids, since they were low in yield and in most cases low also for sugar percentage.

Data for the Logan test are given in Table 4. Crosses with L-37 again showed highest yield and L-19 hybrids were outstanding in sugar percentage. Code 402, the highest yielding entry in 1971, was again among the top yielders this year. There were significant differences between years, as demonstrated by hybrids code 416 and 410, which were high in yield in 1971 but rather low in yield in 1972. Differences were also evident between commercial hybrids as well as the experimental

hybrids in performance at Logan and Farmington. Much of this difference can be attributed to slow germination and poorer stands in the Farmington test plots.

TEST 5

The objective of this trial was to test the general combining ability of five new lines. These new lines are the entries in Table 5 prefixed by 72d05-. The remaining three digits of the entry code number identify the line. Seed for testing each line was obtained by combining seed from crosses of that line to the other four lines. Thus, the data in Table 5 for each line are a measure of the general combining ability of that line.

Two commercial varieties and four inbreds were also included in the test (Table 5). Beet stands were poor except in the two commercial lines (TASCO #1, and UI Hy F). Inbred lines were poorest in beet stand. Inbreds were lower in yield (partly due to poor stand), higher in percent sugar and lower in impurities than the test crosses.

The commercial lines yielded about the same as the test crosses, but were higher in percent sugar and lower in impurities. Some of these lines were heterozygous and poorer quality was expected.

Line 72d05802 exhibited the best combining ability for yield, while line 72d05912 had the poorest combining ability for percent sugar. The combining ability of line 72d05923 for impurities was superior to the other lines.

These data will be used to select the most desirable parents for future crossing and selection.

TEST 6

The objective of this test was to evaluate new triploid hybrids, to observe reciprocal differences between three 2N X 4N vs 4N X 2N triploids, and to compare triploids with single crosses involving the same 2N lines.

Thirteen triploids, 11 2N single crosses and 5 check varieties composed the test. The latter consisted of US 22/2 and four commercial varieties, two from Amalgamated Sugar Company and two from Utah-Idaho Sugar Company. The 29 entries were planted in 2-row plots and replicated 6 times in the field at Logan.

Yield, sucrose percentage and non-sucrose constituents are given in Table 6. There were differences between reciprocals for the three varieties tested; however, only the differences for gross sugar and

tonnage for C562 X AI-12 were significant. Triploid hybrids of C562 (4N) crossed with 129 and AI-12 were higher yielding as pollinators and had higher impurity indices. F.C. 506 was better in yield when used as the female of the cross and had a higher impurity index. Sugar percentages were similar for the reciprocals.

The two highest yielding varieties were triploids. The next four were single crosses. With the exception of L-53, the 2N lines in the study had higher yield in at least one single-cross combination than they did in their triploid hybrid combinations.

Hybrids having L-53 or AI-12 as a parent had higher sugar percentage, regardless of the 2N or 4N condition of the other parent.

TEST 7

A transplant versus seeded test was conducted at Logan this year using the same methods as in 1971.

We planted this test in a split-plot design of four replications with three commercial and two high-yielding experimental varieties as whole plots. There were three treatments: (1) transplants 1-month old (2) transplants 2-weeks old and (3) direct seeded. Plots in this test were four rows wide but only the center two rows were harvested.

The transplants were seeded in Japanese paper pots in the greenhouse and watered daily with 1/2 normal Hoagland solution. Transplanting was accomplished with a tractor-mounted single-row tobacco transplanter which allowed uniform 12-inch spacing in the row and at the same time provided water for the roots. Good stands were obtained using this method.

Transplants in all varieties showed some degree of sprangling. The varieties were significantly different in yield (Table 7). The interaction of varieties X planting method showed that varieties behaved differently when seeded or transplanted.

The 2-week old transplants averaged significantly more gross sugar and tonnage than seeded plots. However, for variety 703, the older transplants were highest in yield and significantly better than seeded plot yield.

The month-old transplants produced on the average a higher sugar percentage than the other plantings did. These transplants were significantly superior to the seeded plots. This difference in sugar percentage is contrary to the similarity we have seen other years for this character. The variation in impurity index and non-sucrose constituents was not significant for varieties, plantings or the interaction of variety X planting.

Table 1. New hybrids at Farmington, Utah, 1972. (51 entries, 5 reps)

Code	Description	Acre Yield		Percent	PPM				Beet
		Gross Sugar	Tons Beets	Sugar	Index	N	Na	K	Count
138	A7113 X 0529	9,018	28.95	15.52	632	375	367	2,019	54
107	A7113 X 0532	8,856	30.75	14.45	824	418	474	2,397	51
134	F.C. 506 CMS X 0529	8,666	26.85	16.10	589	375	267	1,918	54
136	UI #3 X 0529	8,467	26.74	15.78	661	433	303	2,012	59
151	UI Hybrid D	8,462	27.49	15.41	530	277	285	1,751	48
108	29.53 CMS X 0532	8,253	27.36	15.19	669	321	284	2,370	50
146	29.35 X 0541	8,250	28.48	14.50	668	276	312	2,322	56
133	L-53 CMS X 0529	8,239	26.34	15.61	592	348	276	1,919	48
135	AI-12 X 0529	8,213	26.30	15.66	673	350	292	2,407	58
142	AI-12 CMS X 0541	8,073	27.42	14.69	743	358	409	2,347	57
101	129 CMS X 0532	8,010	27.39	14.59	720	381	335	2,205	46
106	S 33 CMS X 0532	7,964	27.02	14.86	663	309	329	2,231	50
103	F.C. 506 CMS X 0532	7,961	26.37	15.14	700	378	321	2,259	48
122	S 33 CMS X 0531	7,801	26.74	14.54	661	325	338	2,058	53
143	UI #B X 0541	7,718	28.20	13.64	514	151	378	1,568	52
105	UI #B X 0532	7,713	25.66	15.05	735	432	280	2,287	50
118	L-53 CMS X 0531	7,687	27.19	14.15	632	227	368	2,154	49
104	AI-12 CMS X 0532	7,659	25.46	15.06	696	282	267	2,680	48
144	S 33 CMS X 0541	7,621	28.24	13.53	772	345	400	2,242	49
148	Tasco #1	7,479	24.71	15.16	541	266	283	1,815	46
131	128 CMS X 0529	7,345	22.88	16.10	529	330	202	1,784	48
150	UI Hybrid B	7,236	24.13	14.90	628	317	415	1,889	48
139	29.35 X 0529	7,160	23.08	15.56	574	322	239	1,943	52
140	128 CMS X 0541	7,133	26.85	13.32	756	322	449	2,093	52
141	133 CMS X 0541	7,082	25.59	13.90	772	370	512	2,102	46
145	A7113 X 0541	7,060	25.96	13.53	851	375	642	2,190	51
149	Tasco #3	7,020	23.08	15.25	512	226	249	1,803	47
124	29.53 X 0531	7,020	23.32	15.04	574	281	210	2,037	51
123	A7113 X 0531	6,909	23.18	14.79	632	298	317	2,113	51

Table 1. (continued)

Code	Description	Acre Yield		Percent	PPM				Beet
		Gross Sugar	Tons Beets	Sugar	Index	N	Na	K	Count
132	129 CMS X 0529	6,679	21.65	15.44	644	390	310	1,981	54
102	L-53 CMS X 0532	6,677	22.81	14.67	750	388	359	2,324	43
137	S 33 CMS X 0529	6,663	21.62	15.40	515	236	270	1,843	45
121	UI #B CMS X 0531	6,622	22.03	15.01	605	330	231	1,973	50
128	UI #B X 0528	6,411	20.26	15.79	538	360	232	1,718	47
126	L-53 CMS X 0528	6,307	20.02	15.68	560	329	282	1,795	42
147	US 22/2	6,290	20.91	15.11	653	358	402	1,939	43
117	129 CMS X 0531	6,046	20.16	15.01	569	259	236	2,047	47
119	F.C. 506 CMS X 0531	5,839	19.82	14.70	558	207	301	2,032	43
120	AI-12 CMS X 0531	5,682	19.01	14.90	657	277	271	2,413	48
109	128 CMS X 0530	5,491	20.74	13.24	506	200	336	1,397	54
127	F.C. 506 CMS X 0528	4,986	15.58	15.94	507	276	268	1,746	34
114	AI-12 CMS X 0530	4,983	18.12	13.77	527	187	324	1,705	58
113	F.C. 506 CMS X 0530	4,847	18.43	13.27	596	200	467	1,694	53
111	L-53 CMS X 0530	4,823	18.26	13.10	565	175	471	1,575	49
112	S 33 CMS X 0530	4,585	17.14	13.41	772	345	400	2,242	47
130	A7113 X 0528	4,497	14.39	15.65	553	303	339	1,778	27
110	129 CMS X 0530	4,353	16.19	13.48	535	164	369	1,686	49
115	UI #B X 0530	4,285	16.26	13.24	514	154	378	1,568	48
116	A7113 X 0530	4,155	15.95	13.11	602	177	508	1,713	50
129	29.35 X 0528	3,102	10.05	15.63	485	250	221	1,707	18
125	129 CMS X 0528	2,394	7.81	15.36	520	251	217	1,885	12
Mean of all varieties		6,701	22.72	14.95	625	301	336	1,994	48
S.E. of mean		1,117	3.71	0.60	90	87	102	161	5.7
L.S.D. (5% point)		1,392	4.63	.74	112	103	129	201	7
C.V. Percent		16.67	16.34	4.05	14.83	28.92	30.30	8.88	11.96
Calculated F		9.62**	9.04**	11.11**	5.15**	3.34**	4.17**	13.85**	11.49**

** Significant at 1% level

Table 2 New hybrids at North Farm, Logan, Utah, 1972. (51 entries, 5 reps)

Code	Description	Acre Yield Gross Sugar	Acre Yield Tons Beets	Percent Sugar	Index	PPM N	PPM Na	PPM K	Beet Count
207	A7113 X 0532	9,234	29.09	15.89	613	365	282	2,028	70
206	S33 CMS X 0532	9,185	28.92	15.88	573	359	231	1,875	69
202	L-53 CMS X 0532	8,980	29.09	15.45	637	343	319	2,082	71
205	UI #B X 0532	8,726	27.49	15.86	569	358	196	1,894	77
208	29.53 CMS X 0532	8,668	28.00	15.46	574	348	196	1,884	71
204	AI-12 CMS X 0532	8,239	26.17	15.74	634	349	246	2,240	71
234	F.C. 506 CMS X 0529	8,097	24.57	16.49	494	344	168	1,716	73
233	L-53 CMS X 0529	8,047	23.42	17.20	523	413	172	1,707	70
201	129 CMS X 0532	8,015	25.59	15.66	650	458	185	1,977	56
203	F.C. 506 CMS X 0532	7,846	24.61	15.93	597	309	291	2,154	64
218	L-53 CMS X 0531	7,783	25.66	15.11	672	452	290	1,842	70
243	UI #B X 0541	7,600	24.64	15.40	615	403	326	1,700	73
236	UI #3 X 0529	7,560	22.54	16.77	405	310	167	1,573	73
240	128 CMS X 0541	7,545	24.81	15.24	646	408	298	1,875	67
242	AI-12 CMS X 0541	7,430	24.33	15.28	712	42[illegible]	331	2,161	80
251	UI Hybrid D	7,340	23.25	15.76	557	428	181	1,527	67
217	129 CMS X 0531	7,275	23.86	15.25	582	361	233	1,772	75
235	AI-12 X 0529	7,268	22.88	15.88	633	460	216	1,874	82
246	29.53 X 0541	7,159	23.08	15.51	576	388	230	1,674	72
238	A7113 X 0529	7,153	21.31	16.78	487	355	208	1,625	69
237	S33 CMS X 0529	7,007	21.52	16.30	542	437	189	1,518	71
241	133 CMS X 0541	6,968	23.66	14.76	667	384	407	1,833	70
244	S33 CMS X 0541	6,944	22.91	15.18	612	374	307	1,773	69
239	29.53 X 0529	6,926	21.18	16.36	467	343	132	1,500	72
222	S33 CMS X 0531	6,911	22.74	15.22	592	389	278	1,658	79
247	US 22/2	6,867	21.82	15.83	585	442	225	1,606	74
248	Tasco #1	6,849	21.96	15.61	528	394	184	1,469	73
232	129 CMS X 0529	6,843	20.43	16.77	552	456	231	1,550	76

Table 2. (continued)

Code	Description	Acre Yield Gross Sugar	Acre Yield Tons Beets	Percent Sugar	PPM Index	PPM N	PPM Na	PPM K	Beet Count
245	A7113 X 0541	6,825	22.43	15.19	685	417	407	1,913	70
228	UI #B X 0528	6,788	20.91	16.21	518	438	180	1,351	69
223	A7113 X 0531	6,762	21.28	15.91	567	395	229	1,701	73
226	L-53 CMS X 0528	6,757	20.60	16.40	534	458	189	1,403	62
250	UI Hybrid B	6,752	21.48	15.70	515	372	213	1,446	69
224	29.53 X 0531	6,661	21.96	15.17	627	413	170	1,907	71
221	UI #B CMS X 0531	6,623	20.84	15.88	533	390	182	1,560	76
220	AI-12 CMS X 0531	6,522	20.81	15.68	583	315	225	2,071	77
249	Tasco #3	6,452	20.77	15.63	516	331	219	1,567	71
227	F.C. 506 CMS X 0528	5,809	17.89	16.19	558	420	259	1,579	43
219	F.C. 506 CMS X 0531	5,789	18.50	15.63	515	305	226	1,686	68
231	128 CMS X 0529	5,782	17.85	16.22	457	325	167	1,434	75
230	A7113 X 0528	5,208	16.29	15.98	540	394	277	1,494	36
211	L-53 CMS X 0530	5,175	18.33	14.03	561	349	252	1,376	64
229	29.53 X 0528	5,117	16.12	15.84	502	355	147	1,544	35
210	129 CMS X 0530	4,979	17.61	14.06	576	389	228	1,322	72
213	F.C. 506 CMS X 0530	4,619	16.66	13.87	697	440	343	1,595	74
212	S33 CMS X 0530	4,563	16.12	14.17	555	335	298	1,390	74
216	A7113 X 0530	4,326	15.27	14.15	576	296	339	1,604	70
214	AI-12 CMS X 0530	4,207	16.02	13.13	642	312	287	1,699	75
209	128 CMS X 0530	3,885	13.64	14.03	466	294	218	1,107	62
215	UI #B X 0530	3,727	13.88	13.43	577	312	239	1,473	66
225	129 CMS X 0528	2,904	8.99	16.11	529	389	194	1,579	22
Mean of all varieties		6,680	21.39	15.51	572	378	240	1,682	68
S.E. of mean		781	2.37	0.57	84	106	54	152	7.67
L.S.D. (5% point)		973	2.93	.72	104	NS	67	188	10
C.V. Percent		11.69	11.07	3.73	14.65	28.05	22.55	9.05	15.92
Calculated F		17.26**	15.98**	11.50**	2.79**	NS	6.82**	12.65**	10.74**

Table 3. Retest of promising material of 1971 at Farmington, Utah, 1972. (45 entries, 6 reps)

Code	Description	Acre Yield		Percent	PPM				Beet
		Gross Sugar	Tons Beets	Sugar	Index	N	Na	K	Count
344	UI Hybrid #G	7,980	25.77	15.46	534	276	322	1,740	53
301	(EL 31 X 030) X L-37	7,901	25.54	15.44	740	510	306	2,078	52
310	7114 X L-37	7,788	25.77	15.17	619	283	351	2,118	52
325	(133 X CT5) X L-19	7,766	24.35	15.90	600	297	410	2,038	52
343	UI Hybrid #F	7,748	25.03	15.48	593	328	336	1,875	53
315	(Ov.1 X CT9A) X L-37	7,552	25.57	14.78	739	371	493	2,189	55
309	(Ov.1 X 9540) X L-37	7,369	25.77	14.35	692	247	487	2,294	53
342	UI Hybrid #C	7,295	23.84	15.32	573	283	394	1,832	48
308	(Ov.1 X CT5B) X L-37	7,246	25.09	14.50	631	199	492	2,164	47
303	(133 X CT5) X L-37	7,229	23.79	15.24	635	344	367	1,972	54
339	Tasco Hybrid #3	7,166	23.76	15.05	558	242	354	1,888	53
341	UI Hybrid #D	7,088	22.91	15.52	585	374	270	1,749	47
345	UI Hybrid #H	7,036	23.73	14.85	551	247	375	1,754	48
302	(S 33 X NB-1)X L-37	6,987	22.37	15.59	613	359	312	1,942	45
330	(EL 31 X 030) X L-19	6,897	21.61	15.91	616	283	436	2,178	41
317	(Ov.1 X NB-1) X L-37	6,855	23.62	14.51	723	276	574	2,275	44
319	(S 33 X NB-1) X 7584	6,835	23.22	14.80	588	246	402	1,930	39
327	(NB-1 X EL 31) X L-19	6,663	20.87	15.98	595	276	410	2,107	42
323	(S 33 X NB-1) X L-19	6,565	20.48	16.08	593	256	353	2,290	48
316	(S 33 X NB-1) X L-37	6,564	22.20	14.73	657	248	471	2,214	44
324	(133 X 030) X L-19	6,560	19.88	16.51	591	326	342	2,109	48
314	(129 X L-53) X L-37	6,420	21.98	14.68	695	321	422	2,198	49
326	(129 X Ov.1) X L-19	6,403	19.26	16.62	521	281	273	1,955	44
328	(129 X Ov.2) X L-19	6,319	19.57	16.12	598	322	295	2,135	45
312	L-53 X L-37	6,179	21.86	14.14	833	371	604	2,381	52
313	(129 X Ov.1) X L-37	6,110	19.85	15.39	583	228	404	2,121	47
336	(133 X NB-1) X 29.008	6,067	19.71	15.38	526	242	427	1,668	48
318	(129 X Ov.2) X L-37	6,053	19.85	15.22	604	248	384	2,133	47
331	(90.68 X 129) X L-19	5,942	18.61	16.02	616	351	363	1,993	37

Table 3. (continued)

Code	Description	Acre Yield Gross Sugar	Acre Yield Tons Beets	Percent Sugar	PPM Index	PPM N	PPM Na	PPM K	Beet Count
338	Tasco Hybrid #1	5,904	18.92	15.49	500	229	294	1,764	43
340	UI Hybrid #B	5,844	19.49	14.91	589	264	416	1,879	41
304	(F.C. 601 X CT5) X L-37	5,745	18.58	15.43	657	378	320	2,086	44
307	(133 X CT5) X 7594	5,675	19.12	14.75	620	270	533	1,808	42
329	(129 X L-53) X L-19	5,611	16.97	16.50	558	293	273	2,126	39
333	(A7113 X 133) X 29.008	5,534	18.07	15.37	575	289	534	1,620	41
334	(Ovana X EL 31) X 29.008	5,467	17.85	15.41	551	289	415	1,651	39
335	(Ovana X A7111) X 29.008	5,446	18.47	14.82	632	302	528	1,790	45
337	US 22/2	5,411	18.16	14.79	609	261	430	1,951	45
321	7114 X 7584	5,280	17.76	14.88	583	272	300	1,947	39
306	L-53 X 7594	5,203	19.32	13.50	789	319	664	2,042	35
305	129 X 0461 S (246)	5,170	16.57	15.64	578	313	356	1,860	28
322	L-53 X 7584	5,048	16.89	15.12	600	309	340	1,898	35
311	129 X L-37	4,924	16.46	15.01	617	220	409	2,243	28
332	(UI SPCA X NB1) X 29.008	4,725	15.64	15.18	548	229	389	1,864	37
320	129 X 7584	2,493	8.34	14.99	561	245	287	1,984	13
Mean of all varieties		6,312	20.69	15.26	613	292	399	1,997	44
S.E. of mean		1,114	3.67	.52	82	77	89	172	6.68
L.S.D. (5% point)		1,267	4.16	.59	94	87	101	195	7.36
C.V. Percent		17.64	17.78	3.40	13.44	26.34	22.30	8.60	15.21
Calculated F		5.45**	5.56**	8.87**	4.17**	3.19**	6.44**	7.34**	8.61**

** Significant at 1% level

Table 4. Retest of promising material of 1971 at North Farm, Logan, Utah, 1972. (46 entries, 6 reps)

Code	Description	Acre Yield Gross Sugar	Acre Yield Tons Beets	Percent Sugar	Index	PPM N	PPM Na	PPM K	Beet Count
403	(133 X CT5) X L-37	10,118	30.43	16.65	578	460	157	1,768	84
401	(EL 31 X 030) X L-37	9,518	28.59	16.65	544	376	182	1,864	76
402	(S 33 X NB-1) X L-37	9,223	28.03	16.43	552	404	143	1,800	77
404	(F.C. 601 X CT5) X L-37	9,011	27.75	16.23	582	427	155	1,850	42
445	UI Hybrid H	8,952	27.72	16.15	521	409	185	1,472	85
419	(S 33 X NB-1) X 7584	8,673	27.69	15.64	600	433	213	1,724	67
428	(129 X Ov 2) X L-19	8,660	25.06	17.25	544	446	155	1,744	74
418	(129 X Ov 2) X L-37	8,620	26.22	16.45	528	359	208	1,748	78
417	(Ov.1 X NB-1) X L-37	8,561	27.38	15.63	665	400	283	2,160	67
425	(133 X CT5) X L-19	8,496	24.41	17.38	534	418	226	1,725	85
414	(129 X L-53) X L-37	8,405	25.46	16.51	577	391	241	1,902	74
443	UI Hybrid F	8,312	25.74	16.16	544	391	194	1,971	82
423	(S 33 X NB-1) X L-19	8,304	23.67	17.52	509	365	170	1,864	68
409	(Ov.1 X 9540) X L-37	8,265	26.53	15.55	671	408	303	2,110	69
424	(133 X 030) X L-19	8,263	23.64	17.52	467	364	198	1,528	72
415	(Ov.1 X CT9A) X L-37	8,225	25.99	15.81	667	453	292	1,982	79
441	UI Hybrid D	8,183	25.00	16.38	539	417	189	1,596	72
412	L-53 X L-37	8,162	26.73	15.27	633	350	289	2,059	75
408	(Ov.1 X CT5) X L-37	7,975	25.57	15.61	619	390	281	1,907	74
436	(133 X NB-1) X 29.008	7,895	25.91	15.24	605	397	297	1,670	71
410	7114 X L-37	7,876	24.41	16.14	539	331	263	1,774	76
442	UI Hybrid C	7,864	24.89	15.78	587	440	215	1,642	68
427	(NB-1 X EL 31) X L-19	7,714	22.54	17.10	547	411	219	1,793	58
421	7114 X 7584	7,674	24.47	15.69	552	403	187	1,587	63
413	(129 X Ov.1) X L-37	7,628	23.67	16.12	557	353	228	1,862	75
426	(129 X Ov.1) X L-19	7,624	21.89	17.40	542	447	197	1,705	61
444	UI Hybrid G	7,624	24.78	16.10	555	443	174	1,556	79
422	L-53 X 7584	7,558	23.33	16.19	558	429	173	1,655	63

Table 4. (continued)

Code	Description	Acre Yield Gross Sugar	Acre Yield Tons Beets	Percent Sugar	PPM Index	PPM N	PPM Na	PPM K	Beet Count
430	(EL 31 X 030) X L-19	7,543	21.69	17.39	498	372	205	1,682	63
431	(90.68 X 129) X L-19	7,543	21.81	17.30	567	451	191	1,836	61
407	(133 X CT5) X 7594	7,531	24.07	15.64	580	397	236	1,704	73
440	UI Hybrid B	7,506	23.73	15.81	614	468	233	1,673	74
429	(129 X L-53) X L-19	7,499	21.81	17.20	475	341	181	1,645	70
406	L-53 X 7594	7,487	24.61	15.21	684	410	347	2,015	58
439	Tasco Hybrid #3	7,338	23.67	15.49	538	314	221	1,762	73
435	(Ovana X A7111) X 29.008	7,324	23.84	15.36	670	500	290	1,706	73
438	Tasco Hybrid #1	7,274	23.36	15.55	576	438	212	1,545	74
446	AN014-1	7,172	22.00	16.26	536	335	262	1,776	72
437	US 22/2	7,028	23.79	16.12	535	337	222	1,777	73
416	(S 33 X NB-1) X L-37	7,015	21.58	16.27	517	309	217	1,830	76
434	(Ovana X EL 31) X 29.008	7,002	22.34	15.66	607	440	266	1,668	56
432	(UI SPCA X NB-1) X 29.008	6,999	22.12	15.82	616	431	231	1,826	59
411	129 X L-37	6,624	20.70	16.00	572	346	256	1,922	48
433	(A7113 X 113) X 29.008	6,528	21.58	15.12	635	416	329	1,715	58
405	129 X 0461 S (246)	6,454	19.43	16.63	533	430	185	1,552	75
420	129 X 7584	4,853	15.62	15.51	589	390	215	1,784	30
Mean of all varieties		7,836	24.32	16.19	571	402	224	1,764	69
S. E. of mean		924	2.11	0.54	75	105	46	137	7
L.S.D. (5% point)		1,051	2.39	0.61	86	NS	52	156	8
C.V. Percent		11.79	8.68	3.33	13.20	26.20	20.44	7.76	14.13
Calculated F		5.60**	9.43**	9.93**	2.74**	NS	6.73**	7.29**	14.53**

** Significant at 1% level

Table 5. Means of each entry for gross sugar, root weight, % sugar and impurities.

Entry	Gross Sugar	Root wt tons/A	% Sugar	Index	N	Na	K
72d611	4496	14.88	15.13	650	363	372	1947
72d618	6252	20.19	15.49	652	388	280	2094
72d619	5181	16.60	15.64	609	338	360	1979
72d627	4986	16.29	15.41	636	350	327	2047
72d05802	8220	28.45	14.54	770	380	551	2175
72d05912	7540	27.09	13.98	796	352	705	2036
72d05913	7666	26.13	14.71	801	391	604	2296
72d05923	7710	25.88	14.91	682	302	516	2137
72d05937	7757	26.95	14.42	802	353	529	2468
Tasco #1	7824	25.71	15.28	587	309	307	1911
UI Hy F	8331	26.36	15.99	580	351	318	1833
Mean	6905	23.14	15.04	688	352	442.98	2084
LSD	1255	4.48	.62	96	105	100	276
CV	15.74	16.79	3.59	12.13	25.93	19.679	11.47

Table 6. Variety test to evaluate new triploid hybrids, North Farm, Logan, Utah, 1972 (29 entries, 6 reps)

Code	Description	Acre Yield Gross Sugar	Acre Yield Tons Beets	Percent Sugar	Index	PPM N	PPM Na	PPM K	Beet Count
607	C562 CMS X L-53	8,635	26.11	16.54	488	354	234	1,486	78
613	F.C. 34 CMS X C562	8,615	27.55	15.63	470	296	154	1,538	53
623	L-53 CMS X 129	8,225	25.71	16.01	546	398	231	1,586	77
621	L-53 CMS X 128	8,170	25.85	15.80	581	432	249	1,596	76
617	L-53 CMS X 133	8,129	25.09	16.18	553	410	274	1,556	76
627	Tasco #3	8,112	25.96	15.63	527	345	212	1,614	86
616	AI-12 CMS X L-53	8,086	24.47	16.56	551	387	204	1,795	77
608	C562 CMS X 133	8,038	25.51	15.76	496	337	197	1,498	82
624	AI-12 CMS X 129	7,933	24.47	16.26	553	374	188	1,829	83
619	L-53 CMS X F.C. 504	7,915	25.03	15.83	658	465	332	1,822	77
629	UI Hybrid D	7,900	24.35	16.23	560	509	167	1,367	79
620	AI-12 CMS X F.C. 504	7,852	24.89	15.77	636	395	281	2,038	85
612	A7113 X C562	7,780	24.47	15.89	582	473	159	1,572	85
615	L-53 CMS X F.C. 506	7,778	23.90	16.28	598	497	238	1,570	69
611	C562 CMS X 128	7,765	24.63	15.78	557	406	223	1,581	63
605	C562 CMS X 129	7,651	23.96	15.98	541	418	209	1,495	66
602	F.C. 506 CMS X C562	7,527	23.87	15.77	527	379	153	1,589	88
603	C562 CMS X AI-12	7,502	23.59	15.90	619	417	266	1,893	82
615	AI-12 CMS X F.C. 506	7,461	22.63	16.49	496	324	178	1,727	81
601	C562 CMS X F.C. 506	7,440	23.59	15.78	514	345	203	1,580	87
618	L-53 CMS X AI-10	7,348	22.85	16.08	557	425	177	,636	74
625	US 22/2	7,329	22.63	16.18	510	331	205	,689	80
628	UI Hybrid B	7,291	22.85	15.95	542	407	219	1,532	76
610	C562 CMS X F.C. 504	7,267	23.08	15.78	593	411	226	1,780	77
609	C562 CMS X AI-10	7,184	22.63	15.90	516	371	143	1,592	76
606	129 CMS X C562	7,054	22.32	15.76	481	348	175	1,399	70
626	Tasco #1	6,939	22.23	15.58	492	306	183	1,574	74

Table 6. (continued)

Code	Description	Acre Yield Gross Sugar	Acre Yield Tons Beets	Percent Sugar	PPM Index	PPM N	PPM Na	PPM K	Beet Count
604	AI-12 CMS X C562	6,657	20.56	16.17	537	431	179	1,502	85
622	AI-12 CMS X 128	6,328	19.57	16.19	554	403	175	1,728	77
Mean of all varieties		7,652	23.94	15.99	547	393	209	1,627	79
S.E. of mean		736	2.25	0.48	73	107	40	125	6.15
L.S.D. (5% point)		841	2.57	0.55	83	NS	46	143	7
C.V. percent		9.61	9.40	3.02	13.32	27.24	19.21	7.67	10.37
Calculated F		3.16**	3.40**	1.92**	2.39**	NS	7.10**	8.58**	4.21**

** Significant at 1% level

Table 7. Transplant vs seeding variety trial, Logan, Utah, 1972 (5 entries, 4 reps)

Analysis of Variance

	DF	Gross Sugar Mean Sq	Gross Sugar F	Tons Beets Mean Sq	Tons Beets F	% Sugar Mean Sq	% Sugar F	Index Mean Sq	Index F
Replications	3	80.85×10^4	NS	7.32	NS	0.5018	NS	55.08×10^2	NS
Varieties	4	93.35×10^5	8.30*	64.65	4.5*	2.4062	NS	95.99×10^2	NS
Error A	12	11.18×10^5		14.49		0.8891		12.44×10^3	
Between Plantings	2	18.90×10^5	NS	13.91	NS	.6588	3.43*	30.66×10^2	NS
Var X Plantings	8	30.20×10^5	4.70**	28.47	4.48**	0.8823	4.60**	59.49×10^2	NS
Error B	30	64.44×10^4		6.35		.1920		50.96×10^2	
Total	59	17.72×10^5		15.27		.6091		69.63×10^2	

	DF	N	F	Na	F	K	F	Beet Count	F
Replications	3	18.39×10^2	NS	86.14×10^2	NS	48.23×10^3	NS	9.39	NS
Varieties	4	11.16×10^3	NS	20.16×10^3	NS	22.11×10^4	NS	62.89	NS
Error A	12	87.06×10^2		10.13×10^3		86.17×10^3		34.16	
Between Plantings	2	66.55×10^2	NS	21.11×10^2	NS	39.70×10^3	NS	45.12	NS
Var X Plantings	8	59.28×10^2	NS	54.92×10^2	NS	58.56×10^3	NS	89.80	2.44*
Error B	30	83.53×10^2		26.31×10^2		27.03×10^3		36.82	
Total	59	78.98×10^2		60.20×10^2		57.99×10^3		44.12	

Means

Code	Description	Gross Sugar Trans #1	Gross Sugar Trans #2	Gross Sugar Seed	Gross Sugar Mean	Tons Beets Trans #1	Tons Beets Trans #2	Tons Beets Seed	Tons Beets Mean
701	Amal. Hybrid #1	6,374	6,724	5,283	6,127	21.85	23.63	18.50	21.33
702	UI Hybrid B	6,161	6,180	6,545	6,295	20.24	21.04	21.68	20.99
703	F&M Com.(USH20)	9,403	8,937	6,445	8,262	29.82	28.33	21.81	26.65
704	Ov CMS X L-37	7,414	7,227	7,928	7,523	23.25	22.87	26.81	24.31
705	Ov CMS X L-19	6,457	7,285	7,255	6,999	21.76	24.40	23.18	23.11
Mean all varieties		7,162	7,271	6,691	7,041	23.38	24.05	22.39	23.28
LSD (5% point):									
Varieties					940				3.38
Planting			518				1.63		
Variety X Planting			1,159				3.64		

Table 7. (continued)

Code	Description	Percent Sugar Trans #1	Trans #2	Seed	Mean	Beet Count Trans #1	Trans #2	Seed	Mean
701	Amal. Hybrid #1	14.62	14.23	14.28	14.38	41	43	40	41
702	UI Hybrid B	15.27	14.68	15.07	15.01	33	47	41	40
703	F&M Com (USH20)	15.79	15.71	14.81	15.43	51	45	39	45
704	Ov CMS X L-37	15.92	15.81	14.76	15.50	42	44	49	45
705	Ov CMS X L-19	14.84	15.01	15.70	15.18	42	43	39	41
Mean all varieties		15.29	15.09	14.93	15.10	42	44	42	43
LSD (5% point):									
Varieties					.84				NS
Planting			.28				NS		
Variety X Planting			.63				NS		
		Index				Amino N			
701	Amal. Hybrid #1	728	729	656	704	486	450	397	444
702	UI Hybrid B	629	630	623	627	424	409	377	403
703	F&M Com (USH20)	710	624	651	662	503	384	431	439
704	Ov CMS X L-37	656	626	716	666	421	384	430	412
705	Ov CMS X L-19	687	707	649	681	450	508	482	480
Mean all varieties		682	663	659	668	456	427	424	435
LSD (5% point):									
Varieties					NS				NS
Planting			NS				NS		
Variety X Planting			NS				NS		
		Na				K			
701	Amal. Hybrid #1	384	356	298	346	1,834	1,853	1,730	1,806
702	UI Hybrid B	254	289	312	285	1,782	1,653	1,800	1,745
703	F&M Com (USH20)	221	203	270	231	2,167	2,098	1,747	2,004
704	Ov CMS X L-37	325	311	263	300	2,035	1,978	2,134	2,049
705	Ov CMS X L-19	309	284	247	280	1,828	1,783	1,794	1,802
Mean all varieties		299	289	278	288	1,929	1,873	1,841	1,881
LSD (5% point):									
Varieties					NS				NS
Planting			NS				NS		
Variety X Planting			NS				NS		

* Significant at 5% level, ** Significant at 1% level

Selection Studies

(a) Competition in Selection (D. L. Doney)

Selection of individual beets for root weight is generally made in space-planted trials. The purpose of space planting is to eliminate the intergenotypic competition of normally-spaced heterozygous populations. In such populations, genetic effects would be confounded with genotypic competitive effects and it would be difficult to identify superior genetic segregates.

However, in commercial plantings, beets are much closer and are under highly competitive conditions. This raises the question "Do beets that do well in non-competitive systems also do well in the highly competitive systems found in commercial plantings?" This study was initiated to investigate the nature and effects of genotypic and environmental competition on and in various selection practices.

Two uniform lines (one inbred and one hybrid) from Amalgamated Sugar Company were used as common competitors. The segregating materials (lines 7181, 9229, AD 917 and D1419) were selected for this study because of their believed heterozygosity.

The two common competitors were planted alternately (i.e. every other plant was the common competitor) with each of the segregating lines, as well as with themselves. Each of the five resulting patterns were planted at 4, 12 and 24-inch plant spacings. The design was a split plot of 6 replications with 36 ft. plots. Plant spacings were whole plots and were bordered on each side by a guard row of equivalent plant spacing.

Planting occurred on May 15; however, poor emergence necessitated replanting in 3 X 10 cm paper pots in the greenhouse on June 8. The entire experiment was replanted with the paper pot transplants on June 26. This shortened the growing season and little competition occurred in the 24-inch spaced plants, but there was strong competition in the close-space plant populations.

At harvest time (October 9 and 10) each plant was cone trimmed, numbered and weighed. Variances and means were computed for each segregating line at each plant spacing, as well as the variances and means of the common competitors with each line at each plant spacing. Competitive ability and influence means and variances were computed from these data. The means and variances of each segregating line, with the common competitors and the common competitors in pure stand, are given in Tables 1 and 2 respectively. Line AD 917 was consistently larger than the other lines and line D1419 was the smallest (Table 1). This suggests that line AD917 has high competitive ability and line D1419 was poor in competitive ability. The ranking of the segregating line's variances was not the same as their ranked means. Line AD 917 had the largest variances, but line D1419 also had large variances,

even though it had the poorest yield (Table 2). There was a high correlation between the means and variances for the common competitors (Tables 1 and 2). The regression of variance on yield for the common competitors was $y = 10x - 113$, where y is the variance and x is the mean. This regression equation was applied to the means of the segregating lines to obtain an estimate of the non-genotypic variance using the following model:

var of common competitor at 24 inch = Ve^2

var of common competitor at 4 and 12 inch = $Ve^2 + Ve^2c$

where Ve^2 = environmental error

Ve^2c = environmental competition variance

The above regression equation gave an estimate of $Ve^2 + Ve^2c$. Therefore, applying this regression equation to the means at the 24-inch spacing gave an overestimate of the non-genotypic variance since there was very little competition, but gave good estimates for the other spacings.

An estimate of the non-environmental variances (i.e. genetic and competitive) is obtained by subtracting the estimated non-genotypic variance from the total variance. In order to measure the relative importance of the different variances, they are reported as percent of the non-genotypic variance (Table 3). Percentages over 100 are considered non-environmental.

For the segregating lines the following models would apply:

var at 24 inch = $Ve^2 + V^2g$

var at 4 and 12 inch = $Ve^2 + V^2g + Ve^2c + Vg^2c$

where V^2g = genotypic variance

Vg^2c = genotypic competition variance.

Subtracting the estimated non-genotypic variance from the total variances of the segregating lines yield the following:

var at 24 inch = $V^2g - Ve^2c$

var at 4 and 12 inch = $V^2g + V^2gc$

At the 24-inch spacing, variances over 100 indicate a genetic variance (V^2g) greater than the environmental competitive variance (Ve^2c). Variances less than 100 mean the opposite (Table 3).

Line D1419 was the only line to have a genetic variance greater than the environmental competitive variance when competing with the hybrid at 24 inches. However, all lines except 9229 had a larger genetic variance than the environmental competitive variance when

competing with the inbred (Table 3). There appears to be more competition at the 24-inch spacing than anticipated. This points out the difficulty of selecting individual beets at normal spacings.

Line 7181 lacked significant genetic and genetic competitive variance at the 12-inch spacing (Table 3). All lines had a larger genetic and genetic competitive variance at the 4-inch spacing than at the 12-inch spacing (Table 3). This increase is probably due to an increased genetic competitive variance under this stronger competitive system. Line D1419 had the largest non-environmental variance throughout (Table 3). This suggests a large genetic competitive variance, i.e. this line is segregating for competitive ability.

The competitive influence of the segregating lines on the common competitors means and variances are presented in Tables 4 and 5 respectively. All the lines reduced the means and variances of the inbred at all spacings. The hybrid had higher means and variances under strong competition (4-inch spacing), but was not affected much under the weaker competitive systems (12 and 24-inch spacings). The hybrid appeared to be a stronger competitor than the segregating lines.

In order to better understand these relationships, relative competitive ability (Table 6) and relative competitive influence (Table 7) values were computed. The relative competitive ability is the proportional change in root yield in mixed stand to the estimated root yield in pure stand. Root yield was estimated by applying the regression equation obtained from the homozygous lines in pure stand to the mean of each line in pure stand at 24-inch spacing. The relative competitive influence is the proportional change in yield of the common competitors grown with the segregating lines to their yield in pure stand.

All segregating lines took advantage of the inbred (Table 6) and significantly reduced its yield (Table 7) in most of the competitive systems. At the 4-inch spacing, all segregating lines except 9229 yielded better than estimated when grown with the hybrid (Table 6). At the same time the hybrid in mixed stands outyielded its pure stand yield (Table 7). This resulted in greater plot yields in mixed stand than the mean of the estimated pure stands. The reverse situation occurred at the 12-inch spacing, i.e. both the hybrid and the segregating lines were affected adversely in mixed stands. Little effect was obtained at the 24-inch spacing. Line D1419 had the least influence on the common competitors. Line AD 917 had the greatest influence on the common competitors, while at the same time it had the greatest competitive ability.

These data indicate that big differences exist in competitive ability and competitive influence. These lines differed in their genetic segregation for these characters. Thus, selection for competitive ability or competitive influence could be achieved in those lines with greatest genetic segregation.

Genotypes with high competitive ability and low competitive influence should theoretically have the best yield in pure stand. Future research will look into this aspect of competition.

(b) Specific Gravity Selection for High Sugar Percentage (J.C. Theurer)

At harvest in 1971 competitive roots from two heterozygous varieties 9229 and 629 were divided into three groups on the basis of their specific gravity (sp. gr.). The #1 selections were those having high specific gravity and the #3 represented those of low specific gravity. The objective of this experiment was to see if selection for high sugar percentage could be made in mother beets topped with a cone-like crown so they could be used in further breeding studies, based on the specific gravity of the roots.

Fifteen to 20 plants of each sp. gr. selection for each variety were placed in separate isolation chambers and allowed to produce open-pollinated seed. The seed of 9229 parent, 9229 sp. gr. selections #1, #2, #3, 629 sp. gr. selections #1, and #3 were planted in 2-row plots in 7 replications in the field at Logan. At harvest all beets in each row were weighed and run through salt solutions that divided beets of the parent variety into three near equal lots. All beets of each field row were run through the spreckles saw and the pulp was analyzed for sugar percentage and non-sucrose constituents. Data on the performance of these selections and their parents are shown in Table 8. Selection #1 sp. gr. for variety 9229 showed a predominance of plants in class #1 as indicated by the 1.86 sp. gr. value. Sp. gr. #2 and #3 selections were respectively higher in average score. The same relationship is evident for sugar percentage. Sp. gr. selection #1 had the highest and selection #3 had the lowest sugar percentage. Differences were small in the average score of 629 variety beets for selections #1 and #3. However, the sugar percentage indicates specific gravity selection was effective in this variety also. Beets selected for low specific gravity (sp. gr. #3) tended to be larger in size and resulted in more tonnage in their progenies than did the other sp. gr. selections.

A second group of 1971 specific gravity selections were crossed by hand. Within each sp. gr. class, we interchanged small glassine bags from each fertile plant to each genetic male-sterile plant. Seed of each cross was harvested separately and two replicates of a single-row plot were planted in the field. A row of the parent variety was also planted every 12th row.

Twelve competitive beets were harvested by hand from each row. The beets were cone-topped so as to leave a crown that would allow continued growth of the beet for seed production. Each sample was run through salt solutions and classified into specific gravity classes as was mentioned previously for the other selections. Individual roots

were sampled by taking a core of tissue through the root where it was widest in diameter. Samples were macerated in Oster blenders and the sugar percentage and impurity factors determined by routine laboratory procedures.

The data from all of the lines within a specific gravity class were combined for this report. Significant differences were noted in specific gravity classes and in sugar percentage. Progenies of 9229 sp. gr. #1 selected in 1971 had mostly sp. gr. #1 beets in the 1972 population as indicated by the 1.5 average value for each variety. Sp. gr. class #2 gave average readings near 2.0 and sp. gr. class #3 gave higher readings. A direct linear association for sugar percentage was noted with the #1 sp. gr. class averaging the highest sugar percentage. An inverse sugar percentage vs tons of beets was noted for variety 9229. The findings of this study demonstrate that specific gravity can be used to select for sugar percentage in the root regardless of whether the crowns are removed from the beets or cone-shaped crowns are left on the root.

Table 1. Means of each line with the common competitors at the 3 plant spacings.

	4"		12"		24"	
	Inbred	Hybrid	Inbred	Hybrid	Inbred	Hybrid
7181	48.40	21.92	75.07	47.42	106.37	95.43
9229	38.31	15.02	69.17	54.12	94.60	87.79
AD 917	54.86	30.18	93.75	59.73	106.50	96.82
D1419	36.87	17.91	61.11	43.43	77.80	57.98
Inbred	3.71		11.24		15.67	
Hybrid		10.26		37.63		58.51

Note: Data on a per plant basis.

Table 2. Variances of each line with the common competitors at the 3 plant spacings.

	4"		12"		24"	
	Inbred	Hybrid	Inbred	Hybrid	Inbred	Hybrid
7181	517.14	154.55	590.65	329.20	1463.78	736.72
9229	380.57	109.91	778.27	330.86	753.76	782.20
AD 917	641.50	371.57	1044.62	633.51	1335.88	739.67
D1419	347.23	140.31	734.92	472.62	1208.76	840.86
Inbred	5.15		28.10		41.61	
Hybrid		46.67		435.17		580.47

Note: Data on a per plant basis.

Table 3. Variances as percent of non-genotypic [a] (environmental plus non-genotypic competitional) variance.

	4"		12"		24"	
	Inbred	Hybrid	Inbred	Hybrid	Inbred	Hybrid
7181	139*	145*	93	92	154*	88
9229	141*	190**	134*	78	91	103
AD 917	147*	200**	127	131*	140*	87
D1419	136*	210**	147*	147*	181**	179**

(a) = computed from regression analysis of homozygous lines

* = significant genetic and/or genetic competitive variances at p = .05
** = " " " " " p = .01

Table 4. Competitive influence of segregating lines on the means of the inbred and hybrid

	4"		12"		24"	
	Inbred	Hybrid	Inbred	Hybrid	Inbred	Hybrid
7181	1.975	13.09	7.22	38.88	13.52	62.00
9229	2.13	14.18	8.33	34.07	12.56	65.42
AD 917	1.88	10.73	7.39	32.14	13.65	56.80
D1419	3.39	11.95	9.43	36.26	14.84	72.42
Inbred	3.71		11.24		15.67	
Hybrid		10.26		37.63		58.51

Note: Data on a per plant basis.

Table 5. Competitive influence of segregating lines on the variances of the inbred and hybrid

	4"		12"		24"	
	Inbred	Hybrid	Inbred	Hybrid	Inbred	Hybrid
7181	1.38	91.85	16.31	301.88	26.17	606.87
9229	2.06	113.55	16.69	307.25	38.02	556.69
AD 917	1.06	139.12	12.55	299.66	31.63	360.98
D1419	2.97	68.71	20.80	365.40	25.28	586.50
Inbred	5.15		28.10		41.61	
Hybrid		46.67		435.17		580.47

Note: Data on a per plant basis.

Table 6. Relative competitive ability[(a)] of each heterozygous line with the two homozygous lines at 3 plant spacings.

	4"		12"		24"	
	Inbred	Hybrid	Inbred	Hybrid	Inbred	Hybrid
7181	2.58**	1.17*	1.14*	.72**	1.13*	1.01
9229	2.15**	.85*	1.11*	.87*	1.06	.98
AD 917	3.09**	1.70**	1.51**	.96	1.20**	1.09
D1419	2.54**	1.23**	1.20**	.85*	1.07	.80*

(a) Relative competitive ability = proportional change in root yield in mixed stand to estimated root yield in pure stand.

Root weight per plant was estimated by applying the regression equation obtained from the homozygous lines in pure stand to the mean of each line at 24 inch spacing.

* = significant change at p = .05
** = " " p = .01

Table 7. Relative competitive influence[(a)] of the segregating lines on the common competitors.

	4"		12"		24"	
	Inbred	Hybrid	Inbred	Hybrid	Inbred	Hybrid
7181	.53**	1.27**	.64**	1.03	.86*	1.05
9229	.57**	1.38**	.74**	.91	.80*	1.11*
AD 917	.51**	1.04	.66**	.85*	.87*	.97
D1419	.91	1.16	.84*	.96	.95	1.23**

(a) relative competitive influence= proportional change in yield of the common competitors grown with the segregating lines to their yield in pure stand.

* = significant change at p = .05
** = " " p = .01

Table 8. Test of specific gravity selections, 1972. (6 entries, 7 reps)

Code	Description	Acre Yield Gross Sugar	Acre Yield Tons Beets	Percent Sugar	Specific gravity Av. 1/	Index	PPM N	PPM Na	PPM K	Beet Count
1743	Specific gravity #1, 9229	4,554	13.99	16.29	1.86	520	426	185	1,431	48
1744	Specific gravity #2, 9229	4,151	12.75	16.21	2.14	488	348	222	1,455	44
1745	Specific gravity #3, 9229	5,426	17.43	15.51	2.64	559	360	256	1,665	52
9229	Check	4,799	15.25	15.69	2.11	502	326	244	1,507	51
1747	Specific gravity #1, 629	3,578	14.98	15.59	2.50	619	471	272	1,591	64
1749	Specific gravity #3, 629	4,894	17.91	14.88	2.86	682	455	339	1,766	61
Mean of all varieties		4,567	15.39	15.70	2.22	562	398	253	1,570	54
S.E. of mean		608	1.67	.47		64	95	52	102	6.67
L.S.D. (5% point)		663	1.82	.52		70	104	57	111	7
C.V. percent		12.61	10.83	3.02		11.41	23.97	20.65	6.50	19.90
Calculated F		4.40**	9.91**	8.19**		9.70**	2.84**	6.91**	11.32**	9.71**

1/ Average classification of individual beets into 3 groups based on relative specific gravity not actual specific gravity

** Significant at 1% level

Table 9. Selections from specific gravity method, North Farm, Logan, Utah, 1972.

Description	Obs.	Tons Beets	Specific Gravity	Percent Sugar	PPM Index	PPM N	PPM Na	PPM K	Count
Specific gravity #1, 9229	9	17.67	1.52	15.91	487	268	348	1,536	60
Specific gravity #2, 9229	12	20.15	1.73	15.46	497	295	356	1,385	69
Specific gravity #3, 9229	12	20.59	1.93	15.20	571	351	362	1,557	73
9229 Check	4	24.61	1.87	15.69	462	253	359	1,383	80
Mean of all varieties		20.17	1.71	15.51	515	303	357	1,477	69
S.E. of mean		3.97	.29	.31	58	70	58	133	12
C.V. percent		19.68	16.66	2.02	11.29	23.31	16.39	9.07	17.16
Calculated F		2.90**	3.65**	9.37*	5.95**	3.32**	NS	4.51**	3.22**
Specific gravity #1, 629	6	22.09	1.53	15.57	661	366	393	1,783	74
Specific gravity #2, 629	12	19.84	1.93	15.48	699	445	379	1,777	69
Specific gravity #3, 629	12	19.97	2.35	15.38	674	452	372	1,820	71
629 check	3	22.23	1.51	15.99	571	335	352	1,885	51
Mean of all varieties		20.51	1.97	15.50	650	424	380	1,798	69
S.E. of mean		3.23	0.28	.31	95	77	69	158	12
C.V. percent		20.51	14.04	1.98	14.49	18.31	18.38	8.79	16.97
Calculated F		NS	15.59**	3.30**	2.04*	3.24**	NS	NS	2.82**

* Significant at 5% level

** Significant at 1% level

Genetic Studies

Linkage Studies Involving an Annual Pollen Restorer and Other Genetic Characters in *Beta vulgaris* L.[1/]

T. E. Roundy and J. C. Theurer

a. Annual Pollen Restorer

Genetic studies to determine the possible linkage association of an annual pollen-fertility restorer isolated from the Ruby Queen variety of table beet and four genetic markers in sugarbeet were completed in 1972. These markers were: red hypocotyl (R) and trout leaf (Tr), associated with the Y-R-B linkage group, and monogerm (m), and virescens (vi_4).

When marker stocks carried male sterility, the restorer inbred was used as the pollinator in making the crosses for linkage tests. Other crosses were made by emasculation of the restorer inbred in the early bud stage before others were ready to dehisce, followed by hand pollination with the appropriate marker line serving as the pollen parent. Both the F_2 and BC_1 generations were evaluated for fertility. In addition, the fertile segregates were crossed to the annual tester line SLC 03 CMS to confirm the segregation of the pollen-restorer gene. Mather's formulas (Mather, K., The measurement of linkage in heredity. Methuem & Company Ltd., London) were used for partitioning the total χ^2 into its three components. The segregation data are shown in Table 1, where χ^2_x values are for 3:1 ratios for the first gene listed, χ^2_y gives the values for 3:1 ratios for the second gene, while χ^2_L gives the value attributable to linkage between the two genes.

In both F_2 and BC_1 there was no indication of linkage between the Rf gene and the genes in the Y-R-B linkage group. However, in the F_2 the χ^2_y value was significant, indicating that the R gene failed to segregate as expected.

Data for the linkage test between the restorer gene and the monogerm factor showed significance at the 3% level for both linkage and deviation of the monogerm factor from the expected ratios. The significance of the m gene was probably due to error in misclassification of plants that produced bigerm flowers on part of the inflorescence and were included in the dominant class. Significance of χ^2_L in the F_2 suggests that linkage may have been present, although the probability of 3% is just slightly less than the 5% rejection point. If linkage was present, it was quite weak. A recombination value of .40 ± .037 was calculated using the product method. This figure compares favorably

[1/] This study was part of a thesis submitted by the senior author to Utah State University in partial fulfillment of the requirements for the M.S. degree.

with a report of .36 ± .017 and .40 ± .015 which Kinoshita found in his study of monogerm and a fertility-restorer gene in Japan. Segregation in the backcross clearly gave no indication of linkage between the two genes. Thus, it is our conclusion that these genes are not associated on the same chromosome.

The data show that the expected 3:1 segregation occurred in the restorer X virescens cross and that there was no linkage between these factors.

b. Yellow-Leaf Mutant

A homozygous yellow-leaf mutant sugarbeet was isolated from genetic material sent to our laboratory by Great Western Sugar Company. Cotyledons and first true leaves of this mutant are normal green in coloration. Phenotypic expression doesn't occur until after approximately 2 months of growth. It expressed itself far better in the field in the summer than in the greenhouse during fall and winter, probably due to greater light intensity and longer photoperiod. This mutant was crossed to the annual SLC 03 and all F_1 plants were normal. The F_2 generation segregated 339 normal : 115 yellow leaf, which gave a probability of .80-.90 for fit to a χ^2 3:1 ratio, indicating that the yellow leaf was due to a single recessive gene. Observations on possible linkage associations with the annual and monogerm genes were made and data are shown below:

Genes	No. Families	XY	Xy	xY	xy	Total	χ^2_x	χ^2_y	χ^2_L
yl m	18	175	57	42	19	293	2.71	0.41	0.91
yl B	18	257	86	78	33	454	0.07	0.36	0.94

The excellent fit to a 9:3:3:1 ratio and the failure to observe significance for χ^2_L indicates that the yellow-leaf gene is not associated with m, nor is it in the Y-R-B linkage group.

New Sources of Male Sterility

J. C. Theurer

In all probability there is only one known source of cytoplasmic male sterility being used today in the production of commercial hybrid sugarbeets in the United States. Male-sterile material has been collected and brought to our laboratory from sugarbeet companies, foreign breeders and plant introduction sources in an endeavor to locate other sources of cytoplasmic male sterility that could prove superior to the one presently in use.

Three sources of male sterility that proved to be identical to the genetic a_1 source were reported last year.

In the winter of 1971-72 crosses were made of eight sources of male sterility with the 201 pollen restorer and three type-O pollinators. The F_1 fertility segregation for some of these crosses, that were evaluated in the greenhouse, is shown in Table 2. Ovana, Japanese, GW 1352, Holland and Danish 4N male steriles gave the expected fertile progeny with 201 Rf and male-sterile progeny with the type-O pollinators. The S and O source was fertile with 201 Rf and male sterile with NB-1, but showed segregation for partial-fertile and fertile plants with SLC 133. The 2936 male sterile X 129 pollinator was the only cross with this male-sterile source and it segregated a single fertile plant. Male sterile 6209 crossed with SLC 128 gave only fertile and partial-fertile offspring, indicating that this male sterile may be the genetic type. The A3900-132 was the most interesting, since its reaction was completely different than expected. While all other male-sterile sources were restored by 201 Rf, only one of seven plants was fertile with this male sterile. In crosses with type-O pollinators NB-1 and 133, A3900-132 also gave partial-fertile offspring. The F_1 populations classified were rather small and more plants need to be observed in each cross for positive certification of their genetic behavior. However, the results do suggest possible different sources of cytoplasmic male sterility than the one in current use.

Continued Studies of Partial Male Fertility in Sugarbeets

A good male-sterile line crossed with a good type-O pollinator generally results in 100% male-sterile offspring. Usually there is little if any environmental effect manifest. By contrast, pollinators that are not type O give progenies of varied degrees of fertility with considerable inter- and intra-plant variation. The fertility of these partial-fertile plants is greatly affected by environmental factors, as well as by the age of the plant. Since 1964 we have been studying the variation in a partial-fertile population of sugarbeet in an effort to understand the genetic mechanism involved in its breeding behavior. Early data was published in 1970 ("Variability in Partial Male-Fertile Sugarbeet", J. Am. Soc. Sugar Beet Technol. 16(3):253-263). The following data were derived from continued investigation of this problem.

Selfed seed of all of the partial-fertile segregates in the 3 populations 5921, 5924 and 5931 were planted in a 70 F greenhouse and maintained under as uniform conditions as possible to those used to classify partial-fertile plants in previous years. The 3 populations were derived from crossing 3 male-sterile segregates from a single partial-fertile plant with the S_{10} annual type-O pollinator, SLC 03. In F_1 population 5921 all 5 plants were partial fertile (Table 2). Population 5924 gave the best fit to a 9 PF : 7 MS ratio while population 5931 fit a 3 PF : 1 MS ratio.

Each F_2 plant was carefully classified for fertility, both visually and by microscopic observation of a sample of aceto-carmine stained pollen. Repeated observations at weekly intervals were made in an attempt to assure as much accuracy as possible in the fertility classification.

All 44 lines in the 3 populations segregated partial male-fertile and completely male-sterile plants (Table 3). Although there was marked differences in the degree of dehiscence and pollen fertility, none of the lines produced a completely fertile segregate. The segregation of each total population gave a good fit to a 7 PF : 9 MS or a 27 PF - 37 MS ratio, which would suggest that partial fertility was governed by 2 or 3 complementary genes. This result was not expected because the F_1 populations were so different in their segregation (Table 3, lines 1-3). It is difficult to find a genetic reason for this pattern of segregation.

Fourteen male-sterile plants from population 6912 and 13 male-sterile plants from population 6913 were crossed back to SLC 03. The fertility of the resulting progenies is given in Table 4. All progenies of 6912 derivation, except line 0968, were 100% male sterile. One plant of this line was partial fertile and produced some seed. In the 6913 population, 4 lines, 0980, 0985, 0992 and 0998, gave 1, 3, 1 and 1 partial-fertile offspring respectively. Figure 1 illustrates the location on four of the five plants where the seed was produced that resulted in the partial-fertile plants. This segregation pattern was not expected and we haven't a good explanation for its occurrence. Extreme care was used in handling the plants and making crosses, so we don't believe the partial-fertile segregates were due to contamination. A change in fertility of a single branch on a male-sterile plant was noted earlier in this material. This change in fertility may be due to an accumulation of fertility-promoting substances or the loss of fertility-inhibiting substances in the plant. It could be an effect of a change in pH or some other micro-environmental factor. It also might be somewhat restricted to the population being studied. Additional research with this material and other diverse partial male-sterile sugarbeet lines is underway.

The Effect of Sterile Cytoplasm on Curly Top Disease Resistance

J. C. Theurer and D. L. Mumford

The outbreak of southern corn leaf blight, its economic significance, and the fact that susceptibility to this disease is associated with sterile cytoplasm, suggested that there should be an investigation into the possibility of disease relationship with sterile cytoplasm in sugarbeet.

Nine pollinator inbreds and their cytoplasmic male-sterile equivalents were evaluated for curly top resistance in the greenhouse

in 1971 using standard testing procedures. In 1971 seven and in 1972 ten pollinators and their equivalent cytoplasmic male-sterile inbreds were inoculated and classified for curly top in the field. The results of these investigations are shown in Table 5. Plants were scored from 0 to 9 with 0 representing plants showing no symptoms and 9 being a dead plant. Thus the larger the score, the greater the susceptibility to curly top. In the greenhouse three fertile lines were more susceptible than their equivalent male steriles and four other inbreds showed the opposite relationship. None of the differences were significant. Similar results were noted in the field experiments.

With the exception of NB-1, differences in resistance between a given pollinator and its CMS equivalent inbred were in the same direction in all three tests. NB-1 fertile was more susceptible to curly top in the field in 1971 and less susceptible in the field in 1972 than its CMS equivalent.

The data substantiate that there is no association of curly top susceptibility with sterile cytoplasm in sugarbeet.

Table 1. χ^2 tests for linkage and deviation in Mendelian ratios of the Rf gene with red hypocotyl (R), trout leaf (Tr), virescent (vi_4), and monogerm (m).

Genes (X Y)	Linkage Phase	No. Families	No. Individuals XY	Xy	xY	xy	Total	χ^2_x	χ^2_y	χ^2_L
R^f R	R F_2	20	167	84	48	17	316	3.31	8.17**	2.03
	R BC_1	11	18	26	24	15	83	0.30	0.12	3.48
R^f Tr	R F_2	10	63	25	34	7	129	3.17	0.002	2.24
	R BC_1	7	20	22	22	22	86	0.05	0.05	0.05
R^f m	C F_2	16	201	42	47	20	310	1.90	4.13*	4.66*
	C BC_1	17	24	19	23	32	98	1.47	0.16	2.00
R^f vi_4	C F_2	30	20	14	14	5	53	3.33	3.33	0.76
	C BC_1	2	5	6	4	3	18	0.89	0.00	0.22

* 5% point of significance
** 1% " "

Table 2. Segregation of new sources of male sterility crossed to US 201 Rf and type-O pollinators.

Current No.	Description		MS	PF	F
7208-26	Ovana	MS X 201 Rf	0	0	5
-52	S & O	MS X "	0	0	4
-61	A3900-132	MS X "	6	0	1
-56	Japanese	MS X "	0	1	23
-70	GW 1352	MS X "	0	0	14
-25	Ovana	MS X 129	8	2	0
-16	Japanese	MS X "	11	1	0
-19	2936	MS X "	6	0	1
-80	New	MS X 128	0	6	12
-51	Holland	MS X NB-1	16	0	0
-54	S & O	MS X "	6	0	0
-63	A3900-132	MS X "	1	3	0
-68	Danish 4N	MS X "	4	0	0
-53	S & O	MS X 133	8	3	2
-62	A3900-132	MS X "	2	2	1
-58	Japanese	MS X "	20	0	0
-67	Danish 4N	MS X "	10	0	0

Table 3. Fertility of F_2 progenies from three partial-fertile populations.

Current Number	Description	No. of lines	No. of plants PF	No. of plants MS
F_1 generation				
5921	MS X SLC 03	1	5	0
5924	"	1	16	11
5931	"	1	64	30
F_2 generation				
6911	5921 ⊗	3	5	6
6912	5924 ⊗	11	76	113
6913	5931 ⊗	30	114	148

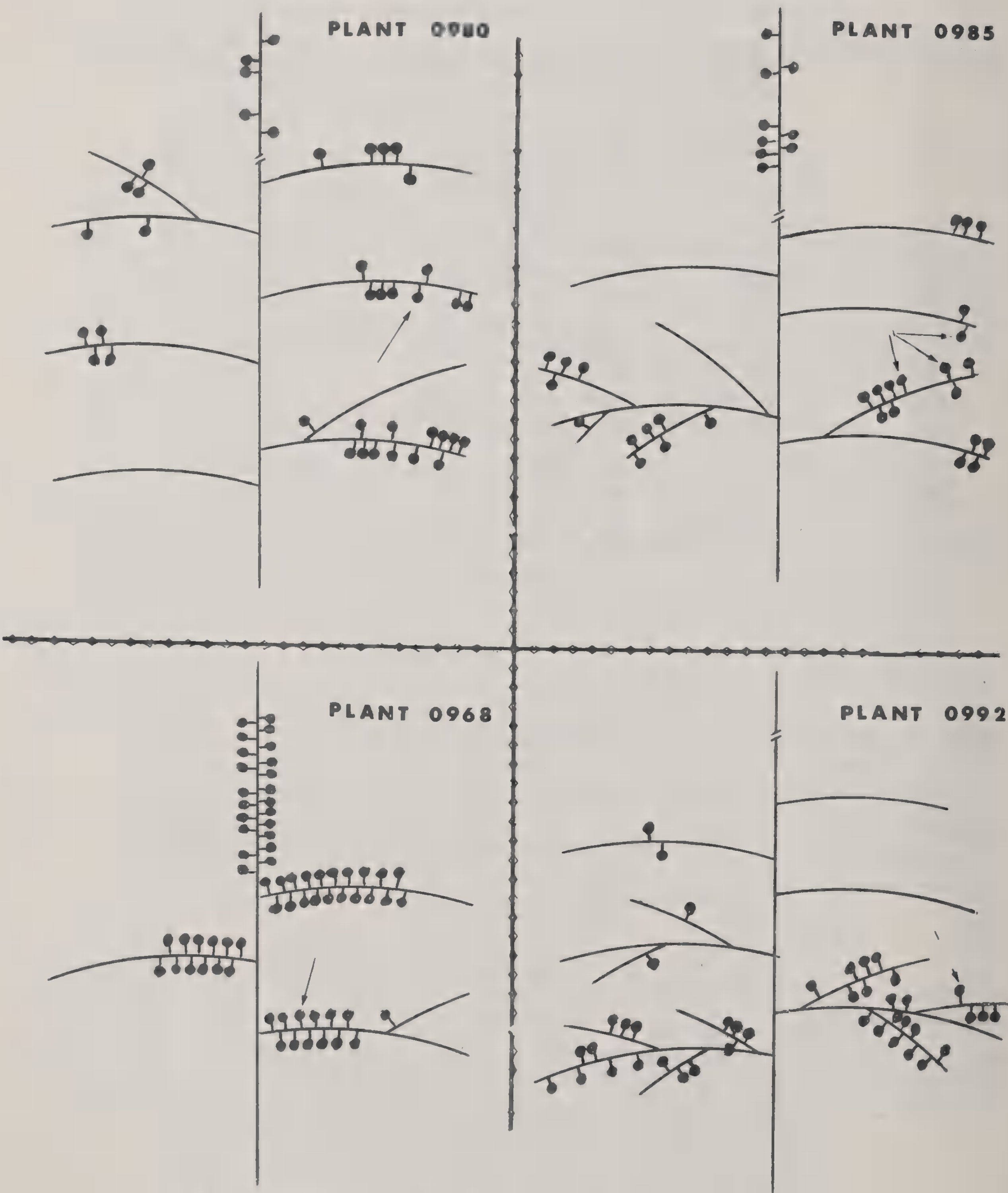


Figure 1. Schematic diagram of seed production on four partial-fertile plants. Arrows indicate location of seed that gave rise to a partial-fertile plant.

Table 4. Fertility of male-sterile segregates in populations 6912 and 6913 crossed to SLC 03

Current No.	Description	No. Plants PF	MS
0951	6912 MS X SLC 03	28	0
0952	" "	2	0
0953	" "	10	0
0955	" "	23	0
0956	" "	52	0
0958	" "	75	0
0961	" "	47	0
0962	" "	17	0
0963	" "	121	0
0964	" "	47	0
0965	" "	13	0
0967	" "	75	0
0968	" "	87	1
0972	" "	22	0
0978	6913 MS X SLC 03	75	0
0979	" "	8	0
0980	" "	40	1
0981	" "	32	0
0982	" "	6	0
0985	" "	57	3
0986	" "	37	0
0987	" "	7	0
0988	" "	13	0
0992	" "	46	1
0994	" "	50	0
0997	" "	33	0
0998	" "	79	1

Table 5. Curly top resistance of CMS vs normal fertile sugarbeet.

Description	Greenhouse 1971		Field 1971		Field 1972	
	Fertile	CMS	Fertile	CMS	Fertile	CMS
03	6.0	6.4	-	-	-	-
L-53	4.4	4.4	-	-	5.3	5.3
128	-	-	-	-	4.6	4.3
129	-	3.1	7.5	7.0	4.0	3.6
133	3.0	3.6	-	-	3.0	3.0
EL 31	-	-	-	-	8.0	8.0
EL 32	6.8	6.3	-	-	7.0	7.0
AI-10	4.1	3.3	5.5	5.0	4.3	3.6
AI-12	-	-	6.5	5.5	5.6	5.3
NB-1	3.1	2.7	5.0	5.5	4.0	3.6
F.C. 504	4.6	5.1	8.0	-	5.6	6.0
F.C. 506	-	-	7.5	7.5	-	-
F.C. 601	2.2	1.7	6.5	6.5	5.6	5.0

Physiological Genetics

Devon L. Doney

Mitochondrial Respiration Studies

(a) Mitochondrial Efficiency vs Growth Rate

The theory of mitochondrial complementation is based on the assumption that growth rate is the result of mitochondrial efficiency, i.e. the more efficient the mitochondria, the faster the growth rate or vice versa. This relationship has not been investigated or demonstrated except that hybrids have more efficient mitochondria than their inbred parents.

The 1971 hybrid-inbred test for mitochondria complementation was tested at three different stages of growth. From these three stages, there appeared to be a correlation of mitochondrial efficiency with growth rate, i.e. mitochondria were most efficient at the August 1 sample date and least efficient at harvest.

This past year tests were initiated to study this relationship more extensively. Two hybrids and their inbred parents were planted in a split-plot design of 4 replications. Two 10-foot rows of each entry in each replicate were harvested at biweekly intervals throughout the growing season. Harvesting of each hybrid set (hybrid and two inbred parents) started on alternate weeks so that one of the two hybrid sets was harvested each week. Harvesting began in mid June and continued until the last of October.

At each harvest, mitochondria were isolated from the roots and assayed for ADP:O ratio (mitochondrial efficiency), R:C ratio, state 3 and state 4 oxidation rate. State 3 is considered the turnover rate in the presence of excess substrate and state 4 is the turnover rate in the resting stage. Data on root weight, blade weight, leaf area, petiole weight and percent dry matter were also taken.

Growth of all lines fit an S-shaped curve, i.e. rate of net growth was slow at first, very fast from mid July to mid September and tapered off toward the end of the growing season. A 3rd order exponential curve of the following type best fit the data.

$$y = k_1 - k_2 X + k_3 X^2 - k_4 X^3$$

where: y = yield

k_1, k_2, k_3, k_4 = constants

X = time

This type of curve was calculated for each entry for root fresh weight, root dry weight, total fresh weight, and total dry weight. The curves for root fresh weight are presented in Figures 1 and 2. The rate of growth of both hybrids was faster than the inbreds throughout the growing season and resulted in a substantially greater yield at harvest (Figures 1 and 2). The female parent had the slowest growth rate in both sets (Figures 1 and 2).

The R:C and ADP:O ratios and state 3 and state 4 rates for the AI-12 CMS X FC 506 hybrid and inbreds are presented in Tables 1, 2, 3 and 4 and for the 129 CMS X A7134 set in Tables 5, 6, 7 and 8. There was little difference in state 4 rates between the hybrids and their parents (Tables 4 and 8). This is to be expected since this is considered the steady or resting stage.

The R:C ratios and ADP:O ratios are related and fluctuated together (Tables 1, 2, 5 and 6). The ADP:O ratios are considered most reliable and are a measure of the mitochondrial efficiency. We will therefore be concerned mostly with the ADP:O ratios. The ADP:O ratios of the hybrids were generally larger than the inbred parents (Tables 1 and 5). However, these differences were significant at only 2 to 3 dates during the growing period. Significant differences in ADP:O ratios were obtained by summing over all the seasonal measurements (Tables 1 and 5).

These differences were in the same order as the field yields (Figures 1 and 2). This suggests a relationship between mitochondrial efficiency and yield. The purpose of this study was to study this relationship more closely. The pattern of the ADP:O ratio throughout the growing season for the two hybrid sets is shown in Figure 3. Both hybrid sets had a similar seasonal pattern. From early July to mid October the ADP:O ratios followed a bell-shaped curve, which best fit a 2nd order exponential curve (Figure 3). The first and last measurements were higher (Figure 3) and gave a rising trend on each end of the curve. The growth rate per period (growth rate per unit of time) for this same period (Figure 1 and 2) also fit a bell-shaped or 2nd order exponential curve.

We computed the correlations between ADP:O ratio and growth rate for this period of time (Table 9). Highly significant correlations were obtained for root fresh weight and total dry weight, especially when the sampling variation was eliminated by fitting the above mentioned curves to the data (Table 9). Root dry weight gave the poorest correlations. Hybrid AI-12 CMS X FC 506 is the only line that did not show a good correlation of ADP:O ratio with total dry weight. This line did not taper off in growth toward the end of the season as much as the other lines. If growth rate is a function of mitochondrial efficiency, then the total dry weight is the measurement that should be correlated to the ADP:O ratio. Since this is where the best correlations were obtained, it is concluded that one of the major

factors affecting growth rate is mitochondrial efficiency. However, the higher ADP:O ratios at the beginning and end of the season is unexplained by this conclusion. Certainly other factors that have equally or more important rolls at different stages of growth must be considered. Another potential problem area may be the isolation technique. It is known that compounds or substances affecting mitochondria coupling are produced in the cell at different stages of growth. These compounds or substances have little effect on the mitochondria in living cells, but have drastic effects on the mitochondria when cells are ruptured during the isolation process. A number of compounds are added to protect the mitochondria during the isolation process; however, these may not be sufficient at certain periods of time.

We also investigated the relationship of net assimilation with mitochondrial efficiency and turnover rate. The net assimilation rate (growth rate per leaf area) gradually decreased throughout the growing season and did not correlate with ADP:O ratio. State 3 oxidation rate appeared to have a curve similar to net assimilation rate. The correlation between state 3 and net assimilation for the AI-12 CMS X FC 506 hybrid and inbred set was significant (.83). However, this correlation for the 129 CMS X A7134 hybrid and inbred set was very low (r = .01). This was probably due to the significant difference between the root-shoot ratios of 129 CMS and A7134, i.e. the top growth of 129 CMS was very small compared to the top growth of A7134 with little difference in root growth. It appears that net assimilation is controlled by other regulating factors.

(b) Complementation

In the 1971 "Sugarbeet Research" report a comprehensive test for mitochondrial complementation involving several hybrids and inbred parents was reported. This study tested complementation at different stages of growth. Four stages (late July, late August, at harvest, and after 1 month of storage at 5 C) were reported. One stage (bolting beets) of this study was not complete at the time of the 1971 report and is reported herein.

Roots of the 1971 hybrid-inbred field test were stored at 5 C for 100 days. They were then planted in 6-inch pots and allowed to bolt (flower). When stalk initiation was almost complete, mitochondria were isolated from the roots for subsequent mitochondrial complementation measurements. Mitochondrial isolation techniques and respiration measurements were the same as previously reported (1971 report).

Of the four measurements made, the ADP:O ratio is considered a measure of the mitochondrial efficiency and is the most precise (Table 10). In general, the four measurements are correlated and follow the same relationship as the ADP:O ratio (Table 10). Some of the better

yielding crosses exhibited complementation. This suggested a correlation of complementation with heterosis. When the actual heterosis obtained from the 1971 field test was compared with complementation, a non-significant correlation of .3 was obtained (Table 10). Therefore, even though a relationship between heterosis and complementation is suggested, it is not of sufficient size and significance to be of value to the plant breeder. We are continuing to test this technique, but on a somewhat reduced scale to try to improve the technique to where it may be useful.

Isozyme Studies

Isozymes are enzymes that perform the same function, but are different in structure. It has been found that a change of one nucleotide in the DNA chain can cause a change of one amino acid in a particular enzyme. This results in a new structural enzyme that performs the same function (isozyme). The electrophoresis technique allows identification of structural changes in identically functional enzymes. We are studying isozymes of several enzymes at different stages of growth and in different tissue. We are also studying isozyme structures in relation to cytoplasmic male sterility.

(a) Anthers from Normal and CMS Plants

Anthesis breaks down in CMS plants in the early tetrad stage. In order to study the effects of CMS on enzyme structure, we felt it was necessary to look at the enzyme structure very close to the time of abortion. Material for this study was collected in the tetrad formation stage. About 300 immature anthers (at this stage of development) were collected from each plant.

Anthers were placed in 1 ml of .1 m phosphate buffer (pH 7.5), lightly macerated and centrifuged. The solution containing the soluble enzymes was refrigerated and saved for electrophoresis and isozyme analysis.

Four lines and their CMS complements (Table 11) were used in this study. Extracts were assayed for esterase isozymes. Three esterase isozymes (E_1, E_2, E_3) were observed in this material. All lines and their CMS counterparts had the E_1 and E_2 isozymes (Table 11). Lines 133, 133 CMS and CT9 CMS had the E_3 isozyme. There appears to be a relationship of the E_3 isozymes with CMS; however, only 4 plants for each line were tested and there was some variation between plants within lines. Therefore, larger numbers of plants are needed for testing. Variation within lines indicates heterozygosity.

(b) Anthers from CMS lines Segregating for Restorer (Rf) (D. L. Doney & J. C. Theurer)

In order to further test the relationship of the esterase isozyme E_3 with CMS, two F_2 lines were selected. Both lines were CMS and

segregating for restorer (Rf). The female parents (129 CMS and NB 1 CMS) were both crossed to restorer 201 Rf to produce the two segregating lines. Anthers were collected from 50 plants of each line in the same manner as previously described. All plants were assayed for esterase isozymes. At a later date each plant was rated for its fertility.

Almost 50% of the 129 CMS X 201 Rf cross was male sterile while the NB 1 CMS X 201 Rf segregated in a 3 fertile or partial fertile to 1 male sterile. All plants in the 129 CMS X 201 Rf cross were absent of the E_3 isozyme. The NB 1 CMS X 201 Rf cross segregated in a 3 present to 1 absent for the E_3 isozyme (Table 12). Every male sterile in this cross was missing the E_3 isozyme. Only two other plants (one fertile and one partial fertile) were missing the E_3 isozyme. Using a 9:3:3:1 ratio a highly significant chi square for linkage of 46.6 and 1.5% crossing over was obtained. It appears as if the gene for E_3 isozyme is very closely linked to the restorer (Rf) gene. Presently, we are testing other crosses and parents to verify this finding. This finding could be of value in a number of different ways, such as determining different cytoplasms and restorers. It may also prove valuable in unraveling the genetics and chemistry of cytoplasmic male sterility.

(c) <u>Growth Rate Survey</u>

A survey of the esterase and peroxidase isozyme patterns in leaves, petioles and roots of two hybrids and their inbred parents was made throughout the 1972 growing season.

The different tissue gave different patterns, indicating structural differences in the different tissue. These patterns also changed during the growing season.

There were some indications of maternal inheritance, however, the analysis of these data is not complete. These data will be further analyzed for areas of potential value. Future work will be concentrated within these areas.

Table 1. ADP:O ratios for AI-12 CMS X FC 506, AI-12 CMS and FC 506 at each harvest date.

Date	AI-12 CMS X FC 506	AI-12 CMS	FC 506	LSD.05
June 26	1.97	1.86	2.03	NS
July 10	1.79	1.70	1.60	.17
July 24	1.75	1.70	1.87	.19
August 7	2.03	1.96	2.11	.11
August 21	1.91	1.94	1.94	NS
September 4	1.90	1.85	1.94	NS
September 18	1.57	1.55	1.75	NS
October 2	1.61	1.49	1.63	NS
October 16	1.29	1.20	1.22	NS
October 30	1.71	1.36	1.55	NS
Mean	1.76	1.66	1.76	.08

Table 2. R:C ratios for AI-12 CMS X FC 506, AI-12 CMS and FC 506 for each harvest date.

Date	AI-12 CMS X FC 506	AI-12 CMS	FC 506	LSD.05
June 26	2.31	2.21	2.33	NS
July 10	1.80	1.70	1.88	NS
July 24	2.88	2.44	2.70	.44
August 7	2.31	2.39	2.35	NS
August 21	2.36	2.17	2.43	NS
September 4	1.88	1.91	2.10	NS
September 18	1.95	1.68	2.09	NS
October 2	2.21	2.19	1.78	.18
October 16	1.95	1.89	1.97	NS
October 30	2.14	1.93	1.89	NS
Mean	2.18	2.05	2.15	.12

Table 3. State 3 oxidation rates for AI-12 CMS X FC 506, AI-12 CMS and FC 506 for each harvest date.

Date	AI-12 CMS X FC 506	AI-12 CMS	FC 506	LSD.05
June 26	73	70	75	NS
July 10	199	118	159	NS
July 24	101	76	96	NS
August 7	91	67	109	NS
August 21	114	100	80	29
September 4	61	80	66	NS
September 18	65	61	72	NS
October 2	60	67	62	NS
October 16	79	74	94	NS
October 30	135	96	92	NS
Mean	98	81	91	15

Table 4. State 4 oxidation rate for AI-12 CMS X FC 506, AI-12 CMS and FC 506 for each harvest date.

Date	AI-12 CMS X FC 506	AI-12 CMS	FC 506	LSD.05
June 26	31	31	32	NS
July 10	109	72	85	NS
July 24	35	31	35	NS
August 7	38	28	35	NS
August 21	47	45	32	13
September 4	31	42	31	NS
September 18	39	29	34	NS
October 2	27	30	35	NS
October 16	40	39	46	NS
October 30	62	50	48	NS
Mean	46	40	41	NS

Table 5. ADP:O ratios for 129 CMS X A7134, 129 CMS and A7134 for each harvest date.

Date	129 CMS X A7134	129 CMS	A7134	LSD .05
June 21	2.07	2.00	2.06	NS
July 3	1.74	1.66	1.65	NS
July 18	1.78	1.69	1.65	NS
July 31	1.85	1.83	1.89	NS
August 14	1.80	1.63	1.76	NS
August 28	2.17	2.08	2.01	NS
September 11	1.74	1.45	1.61	.16
September 25	1.91	1.45	1.53	.20
October 10	1.65	1.43	1.38	.27
October 24	1.76	1.72	1.99	NS
Mean	1.85	1.69	1.75	.08

Table 6. R:C ratios for 129 CMS X A7134, 129 CMS and A7134 for each harvest date.

Date	129 CMS X A7134	129 CMS	A7134	LSD .05
June 21	2.66	2.33	2.80	NS
July 3	1.84	1.62	1.73	NS
July 18	2.17	1.85	1.94	.34
July 31	2.67	2.45	2.92	.47
August 14	2.09	2.11	1.83	NS
August 28	2.19	2.12	2.39	NS
September 11	2.34	1.87	2.12	.39
September 25	2.73	1.89	2.28	.48
October 10	2.62	2.20	2.06	NS
October 24	2.00	1.90	2.13	NS
Mean	2.58	2.26	2.46	.15

Table 7. State 3 oxidation rates for 129 CMS X A7134, 129 CMS and A7134 for each harvest date.

Date	129 CMS X A7134	129 CMS	A7134	LSD .05
June 21	137	128	94	NS
July 3	76	47	66	14
July 18	137	83	99	NS
July 31	123	99	94	NS
August 14	82	84	61	NS
August 28	56	55	90	NS
September 11	85	58	78	NS
September 25	102	91	83	NS
October 10	94	67	81	NS
October 24	88	100	102	NS
Mean	98	81	84	12

Table 8. State 4 oxidation rates for 129 CMS X A7134, 129 CMS and A7134 for each harvest date.

Date	129 CMS X A7134	129 CMS	A7134	LSD .05
June 21	54	55	40	NS
July 3	41	30	38	9
July 18	63	45	50	NS
July 31	45	40	43	NS
August 14	40	41	31	NS
August 28	28	27	37	7
September 11	33	29	36	NS
September 25	36	48	36	NS
October 10	38	30	38	NS
October 24	44	52	47	NS
Mean	41	38	40	NS

Table 9. Correlations between growth rate and ADP:O ratio for root fresh weight, root dry weight, total fresh weight, and total dry weight for each line.

Line	Root weight		Total weight	
	Fresh wt	Dry wt	Fresh wt	Dry wt
	Growth rate X ADP:O			
AI-12 CMS X FC 506	.55	.34	.54	.22
AI-12 CMS	.70*	.34	.65	.73*
FC 506	.54	.36	.58	.55
129 CMS X A7134	.83**	.85**	.34	.42
129 CMS	.85**	.60	.84**	.80*
A7134	.78*	.44	.93**	.62
	Growth rate (from calculated curve) X ADP:O			
AI-12 CMS X FC 506	.77*	-.12	.80*	.30
AI-12 CMS	.95**	.82**	.80*	.90**
FC 506	.97**	.77**	.80*	.91**
129 CMS X A7134	.90**	.87**	.65	.81*
129 CMS	.55	.10	.87**	.86**
A7134	.55	.35	.93**	.84**
	Growth rate (from calculated curve) X ADP:O (from calculated curve)			
AI-12 CMS X FC 506	.93**	-.09	.84**	.35
AI-12 CMS	.95**	.64	.66	.99**
FC 506	.90**	.71*	.67	.98**
129 CMS X A7134	.99**	.94**	.67	.99**
129 CMS	.87**	.28	.98**	.93**
A7134	.87**	.55	.99**	.93**

* = significant at p = .05
** = significant at p = .01

Table 10. R:C and ADP:O ratios and state 3 and 4 respiration rates[a] of mitochondria of eight hybrids, their respective inbreds and 1:1 inbred mitochondrial mixtures of bolting beets.

Cross	Measurement	♀ inbred	♂ inbred	1:1 mix	Hybrid	Heterosis(b) of hybrid
809 CMS X 0461 S_3	R:C	2.41	2.03	2.15	2.38	123
	ADP:O	2.04	1.68	1.74	2.16	
	State 3	70.5	61.1	41.3	97.3	
	State 4	29.8	28.9	19.3	40.0	
129 CMS X 0461 S_3	R:C	2.29	2.50	2.38	2.07	119
	ADP:O	2.02	2.17	2.07	1.85	
	State 3	65.4	60.6	59.8	51.2	
	State 4	29.2	24.2	28.6	26.1	
Ov CMS X (133 X m')	R:C	2.07	1.98	2.01	1.92	128
	ADP:O	1.61	1.70	1.70	1.94	
	State 3	42.2	40.1	45.2	66.0	
	State 4	19.7	20.0	22.3	35.6	
Ov CMS X 0198 S	R:C	2.34	2.05	2.19	1.60	119
	ADP:O	1.84	1.61	1.78	1.39	
	State 3	48.5	54.1	56.3	43.3	
	State 4	20.5	25.9	25.1	28.1	
Ov CMS X 0461 S_3	R:C	1.79	2.58	2.04	2.30	124
	ADP:O	1.86	2.32	1.90	2.08	
	State 3	29.8	44.7	38.8	39.0	
	State 4	16.6	17.3	19.0	17.7	
Ov CMS X A7135	R:C	2.58	2.11	2.37	2.23	114
	ADP:O	2.12	1.97	2.12	1.92	
	State 3	47.3	52.3	48.5	48.9	
	State 4	18.3	24.7	20.4	22.6	

Table 10. (continued)

Cross	Measurement	♀ inbred	♂ inbred	1:1 mix	Hybrid	Heterosis of hybrid
133 CMS X 0461 S_3	R:C	2.11	2.04	2.31	2.09	142
	ADP:O	2.07	1.88	2.14	1.93	
	State 3	60.5	29.8	62.4	46.5	
	State 4	28.7	14.6	27.0	22.7	
133 CMS X L-19	R:C	1.71	2.09	1.95	2.05	122
	ADP:O	1.60	1.69	1.90	1.92	
	State 3	55.3	72.6	56.2	48.9	
	State 4	32.3	34.6	28.7	22.6	

(a) Respiration rate = mμ moles O_2 used/min./mg mitochondrial protein

(b) Hybrid as percent of mid-parent obtained from 1971 field data.

Table 11. Esterase isozymes from anthers of four lines and their CMS counterparts.

Genotype	Isozymes E_1	E_2	E_3
L 33	X	X	X
L 33 CMS	X	X	X
129	X	X	
129 CMS	X	X	
CT9	X	X	
CT9 CMS	X	X	X
128	X	X	
128 CMS	X	X	

Table 12. Fertility rating and absence or presence of E_3 esterase in plants of cross NB 1 X 201 Rf

Cross	Plant No.	Fertility Rating[a]	Presence(+) or Absence (-) of E_3	Plant No.	Fertility Rating	Presence(+) or Absence (-) of E_3
NB 1 X 201 Rf	1	PF	+	26	MS	-
	2	PF	+	27	MS	-
	3	PF	+	28	PF	+
	4	PF	+	29	PF	+
	5	F	+	30	PF	+
	6	PF	+	31	F	-
	7	F-PF	+	32	MS	-
	8	PF	+	33	PF	+
	9	PF	+	34	MS	-
	10	PF	+	35	PF	+
	11	PF	+	36	F-PF	+
	12	PF	+	37	MS	-
	13	F-PF	+	38	PF	+
	14	PF	+	39	PF	+
	15	PF	+	40	PF	+
	16	MS	-	41	MS	-
	17	F-PF	+	42	F	+
	18	F-PF	+	43	PF	-
	19	MS	-	44	PF	+
	20	F	+	45	MS	-
	21	PF	+	46	MS	-
	22	F-PF	+	47	F	+
	23	PF	+	48	MS	-
	24	PF	+	49	MS	-
	25	F-PF	+	50	MS	-

(a) = F = fertile; PF = partial fertile; MS = male sterile

Figure 1. Root fresh weight growth curves for AI-12 CMS X FC 506, AI-12 CMS and FC 506.

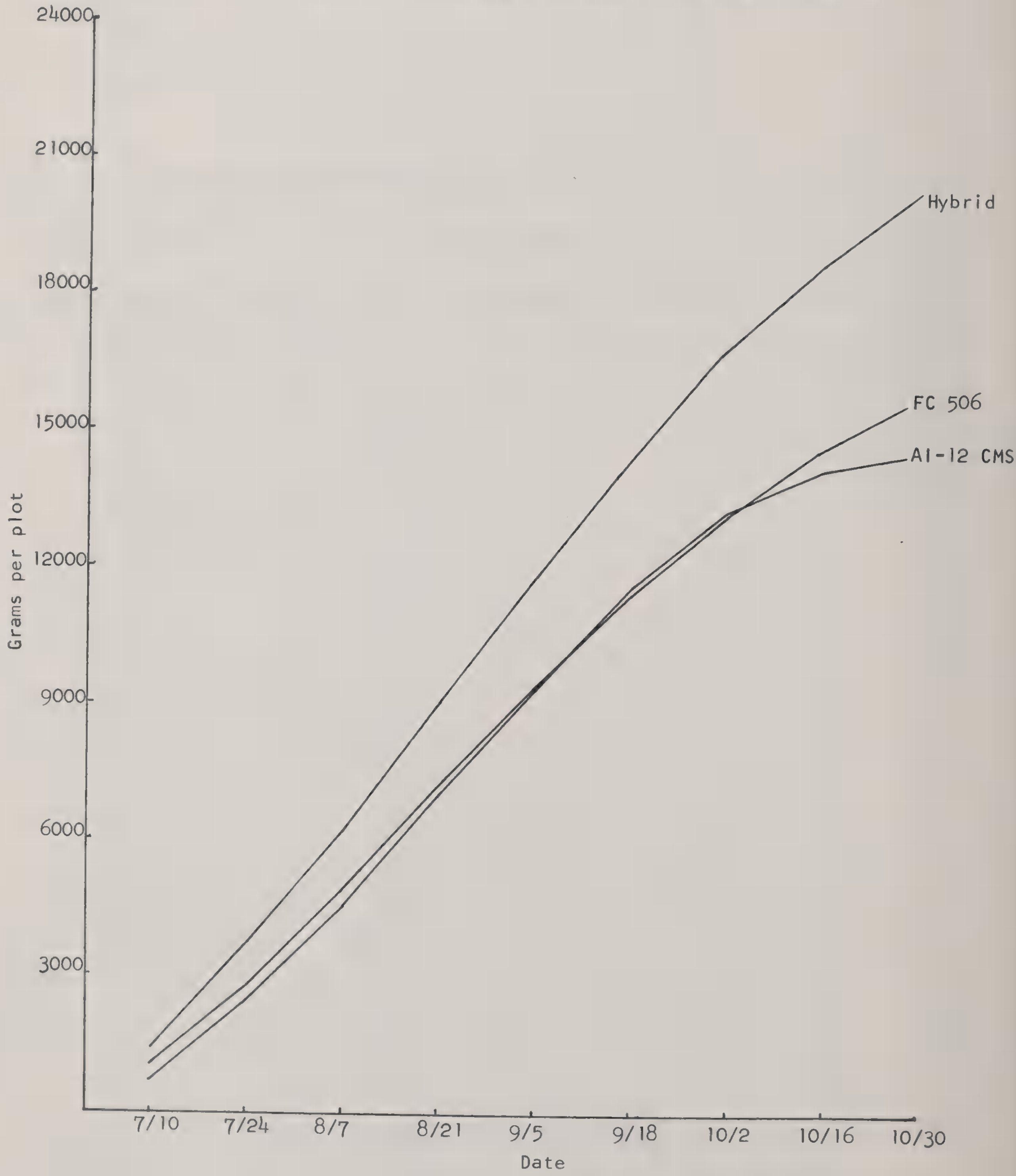


Figure 2. Root fresh weight growth curves for 129 CMS X A7134, 129 CMS and A7134.

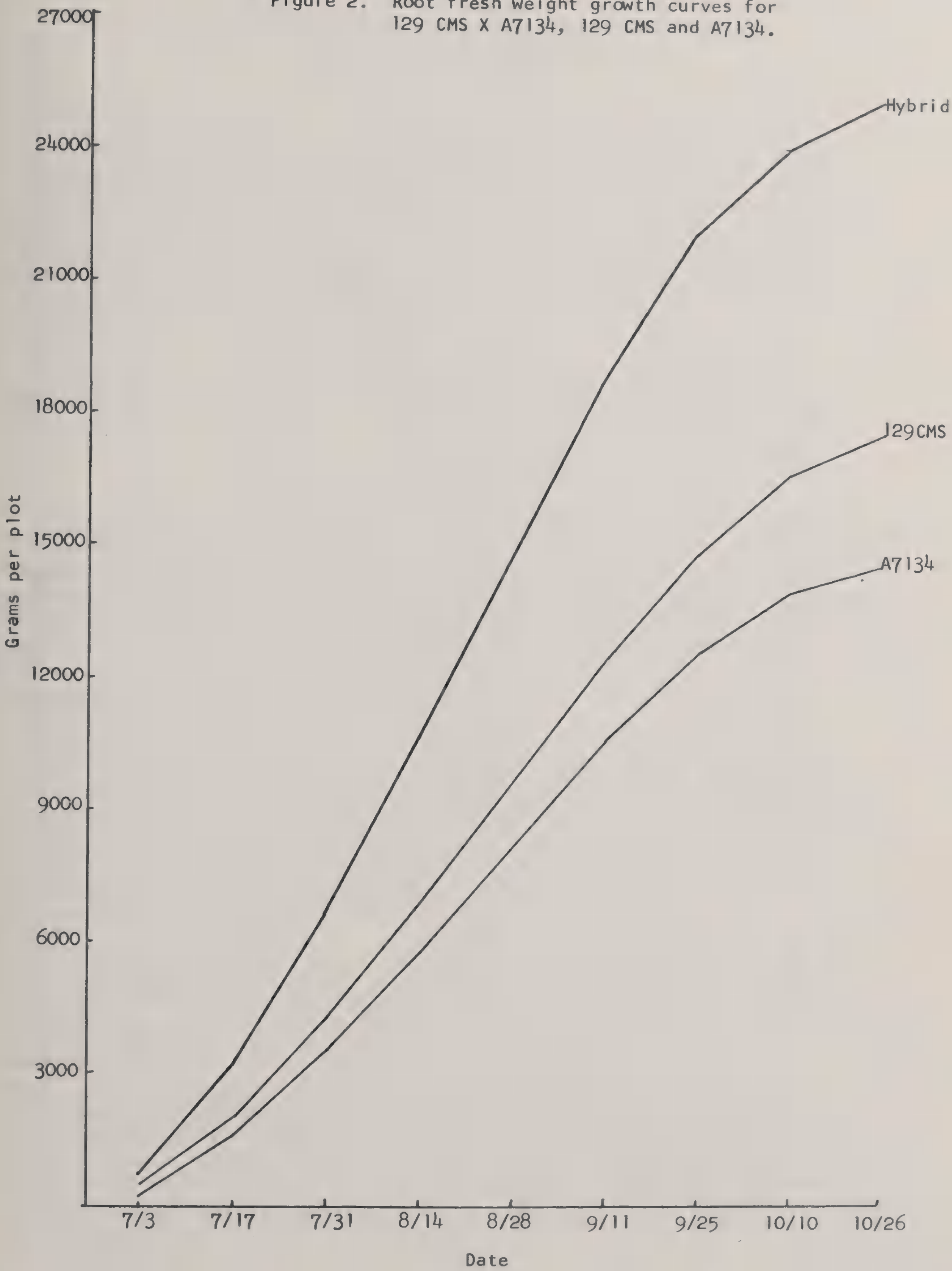
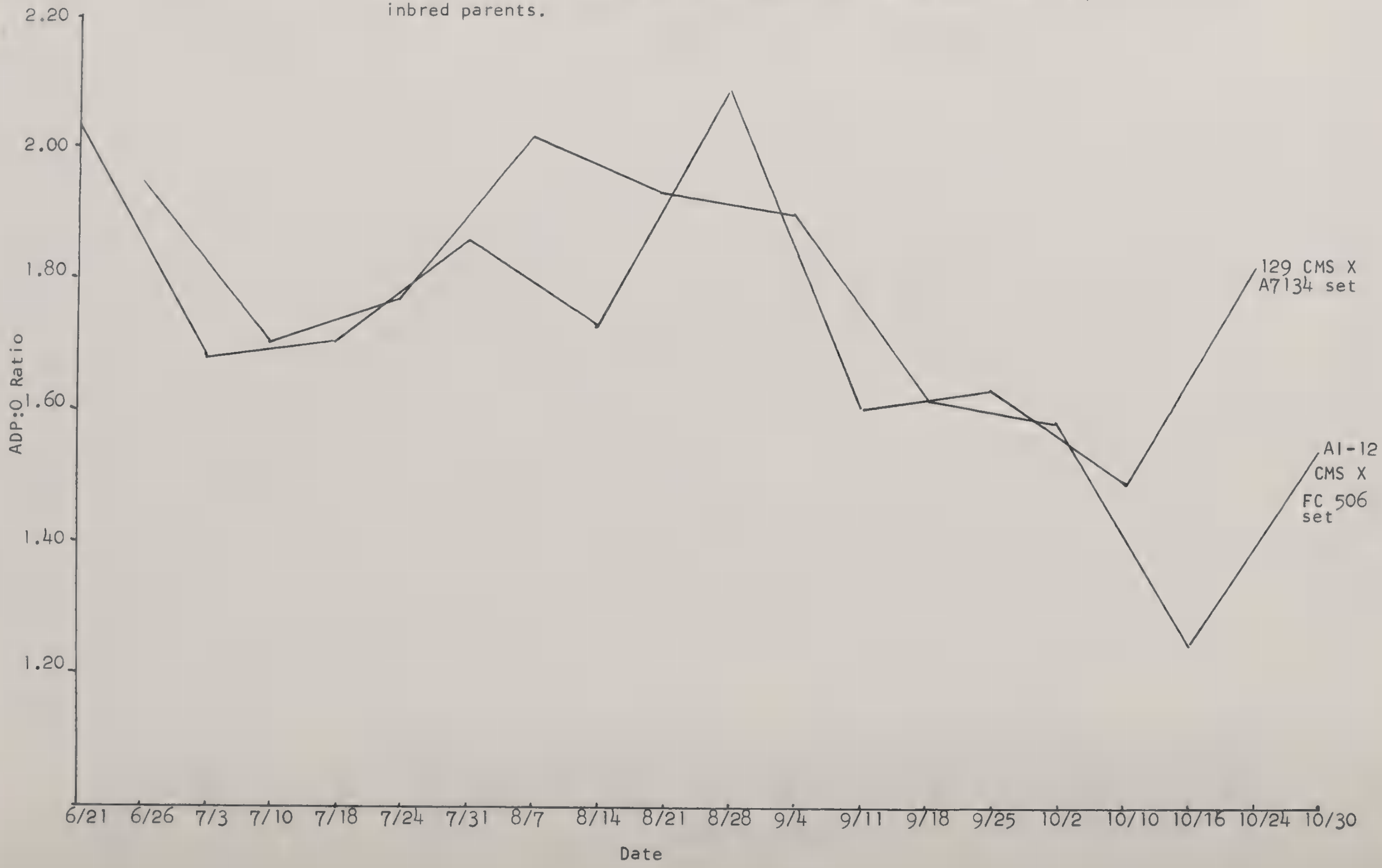


Figure 3. Seasonal fluctuations of ADP:O ratios for hybrids 129 CMS X A7134 and AI-12 CMS X FC 506 and their inbred parents. Each line is the mean of the hybrid and its inbred parents.



Postharvest Activity of Sucrose Degrading Enzymes in Sugarbeet Roots

Roger Wyse

Sucrose in the root can be broken down or converted into various impurity constituents by the enzymes, acid invertase and sucrose synthetase. Acid invertase hydrolyzes sucrose to the reducing sugars, glucose and fructose, and also catalyzes the transfructosylation reaction to produce kestose. Sucrose synthetase catalyzes the breakdown of sucrose to fructose and UDP-glucose. UDP-glucose is an intermediate in the biochemical pathway for the synthesis of more complex polysaccharides possibly including raffinose.

The purpose of this study was to determine the feasibility of assaying these key enzymes as a method of determining varietal storageability.

MATERIALS AND METHODS

Roots were hand harvested on October 11, lightly topped to remove petioles and terminal bud, hand washed and separated into 5 beet samples. Samples for storage were placed in perforated 2 mil polyethylene bags. Storage treatments were 28 days at 3 and 24 C (short-term storage) and 50 and 100 days at 5 and 10 C (long-term storage). No weight loss occurred during storage and the samples were free of mold and sprouting.

Analysis

At each removal from storage the beets were sampled using a brei saw. For enzyme analysis, 30 g of well-mixed brei were added to 50 ml of extraction buffer solution (0.05 M PO_4, pH 7.5; 0.1 mM mercaptoethanol, 0.01 M $NaSO_3$, 0.1 mM EDTA) at 0-5 C. The mixture was stirred periodically for 15 min and then filtered through two layers of cheesecloth and centrifuged at 30,000 xg for 20 min. The supernatant was dialyzed overnight at 5 C against the extraction buffer and then assayed for sucrose synthetase and invertase activity.

Juice was extracted from the remaining brei by squeezing through muslin and immediately frozen. At a later date these juice samples were thawed, clarified (DFS method) (Dexter, et al., 1967) and used for detailed impurity analysis. Reducing sugars, sucrose and amino acids were determined by the methods of Bernfeld (1951), Roe (1949), and Rosen (1957), respectively. In addition, the clarified juices were chromatographed on Whatman 3 MM paper for 24 hrs using a n-Butanol : acetic acid : water (8:2:3) solvent. Raffinose and kestose were located using a diphenylamine - aniline - H_3PO_4 spray. Relative amounts of raffinose were determined by a visual comparison with standards and of kestose by visually ranking relative color intensity among treatments on a scale of 0-4.

Enzyme Assays

Assays for sucrose synthetase and invertase were made at 37 C for 15 and 60 min, respectively. Assay mixtures for sucrose synthetase contained 80 μM sucrose, 0.2 μM EDTA, 1.0 μM NaF, 3.2 μM PO_4 (pH 7.2), 3.5 μM UDP, and 0.03 ml of dialyzed extract in a total volume of 0.2 ml. Assay mixtures for invertase were the same as for sucrose synthetase, except that acetate buffer at pH 5.0 was substituted for the phosphate buffer. Controls for the sucrose synthetase assay were lacking UDP and boiled extracts were used for the invertase assay controls.

Reactions were stopped by adding 1 ml of Nelson's copper reagent. Reducing sugars produced were measured by the method of Nelson (1944). Total protein was determined by the method of Lowry (1951) and then the enzymatic activities were computed as mμM of sucrose hydrolyzed to reducing sugars min^{-1} mg^{-1} of protein.

RESULTS AND DISCUSSION

Raffinose

The raffinose content was low at harvest and remained low during storage at 24 C (Figure 1). These low levels were barely detectable by the chromatographic method used. However, after only 28 days at 3 C, the raffinose content had nearly tripled. Raffinose accumulated in the long-term storage even at 10 C.

Reducing sugars

The reducing sugar content decreased slightly during 28 days at 3 C, but doubled at 24 C. Beets at 10 C accumulated considerably more reducing sugars in the first 50 days than beets stored at 5 C (Figure 1). Between 50 and 100 days the rate of accumulation was the same at both temperatures.

Kestose

No kestose was observed at harvest or in beets stored at 3 C for 28 days (Table 1). However, small amounts were observed in all other treatments.

Enzyme activities

Sucrose synthetase and invertase (pH 5.0) activities did not correlate with changes in raffinose, reducing sugars or kestose concentrations. Invertase activity was low at harvest and decreased to essentially zero after 100 days (Figure 2). Sucrose synthetase activity was high at harvest (7 to 8 times more activity than invertase), but decreased approximately 50% during 100 days of storage.

During short-term storage, sucrose synthetase activity dropped more drastically in the beets stored at 24 C as compared to those at 3 C. Enzyme activity in 5 and 10 C storage did not differ. Pressey (1969) has previously shown that sucrose synthetase activity in potato tubers decreased during storage regardless of temperature.

The level of invertase activity found in this study would indicate that kestose should be present in the beet at harvest. Since it was not, the pH 5 acid invertase studied here apparently is not involved in kestose production. This suggests the presence of other invertase enzymes not active at this pH, or active at pH 5 but are attached to the cell wall and not readily solubilized.

The accumulation of reducing sugars during storage may be the result of rather subtle secondary factors having very little interaction with the genetic makeup of the root. These factors may be such things as mold growth or symbiotic growth of yeast and bacteria within the root, which show no visual signs of physical deterioration. The latter hypothesis is supported by the very low pH 5 invertase activities even in beets which accumulated reducing sugars and kestose.

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Table 1. Relative kestose concentrations under several storage conditions.

At Harvest	Storage period, days: 28		50		100	
	3 C	24 C	5 C	10 C	5 C	10 C
0*	0	.42(3-12)**	.9(5-12)	1.8(10-12)	.67(4-12)	.67(3-12)

* numbers indicate relative kestose concentrations (0 = lowest; 4 = highest)

** the first number in parenthesis indicates the number of replications having kestose, the second, the total number of replications.

Fig 1. Amino acid, raffinose and reducing sugar content of roots in short and long term storage experiments.

3C 24C 5C 10C

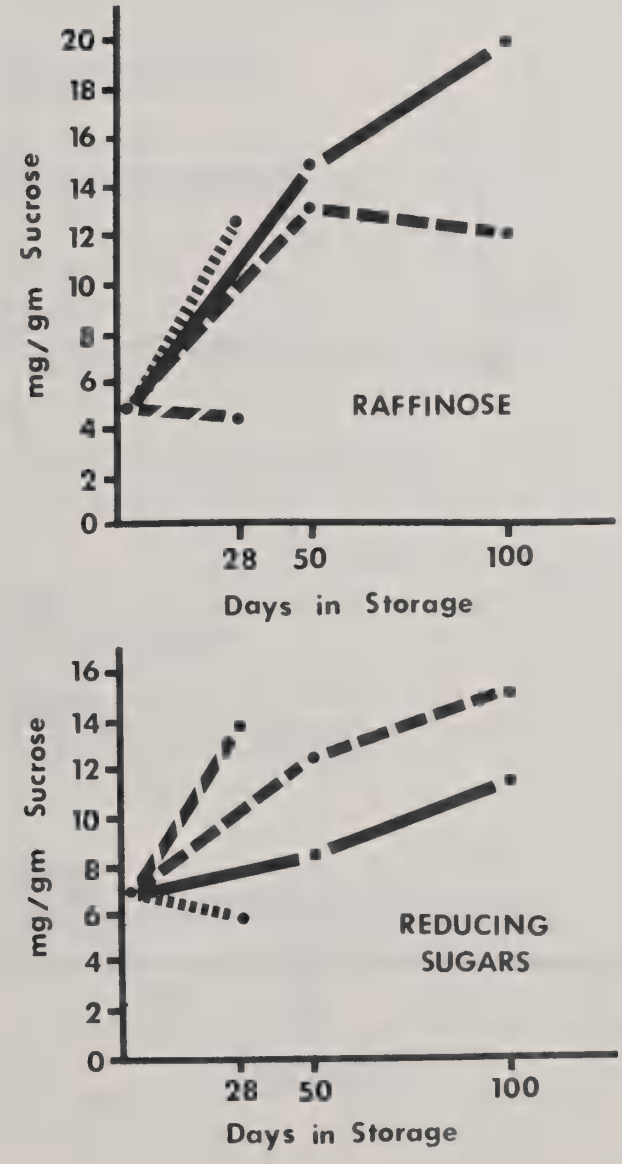
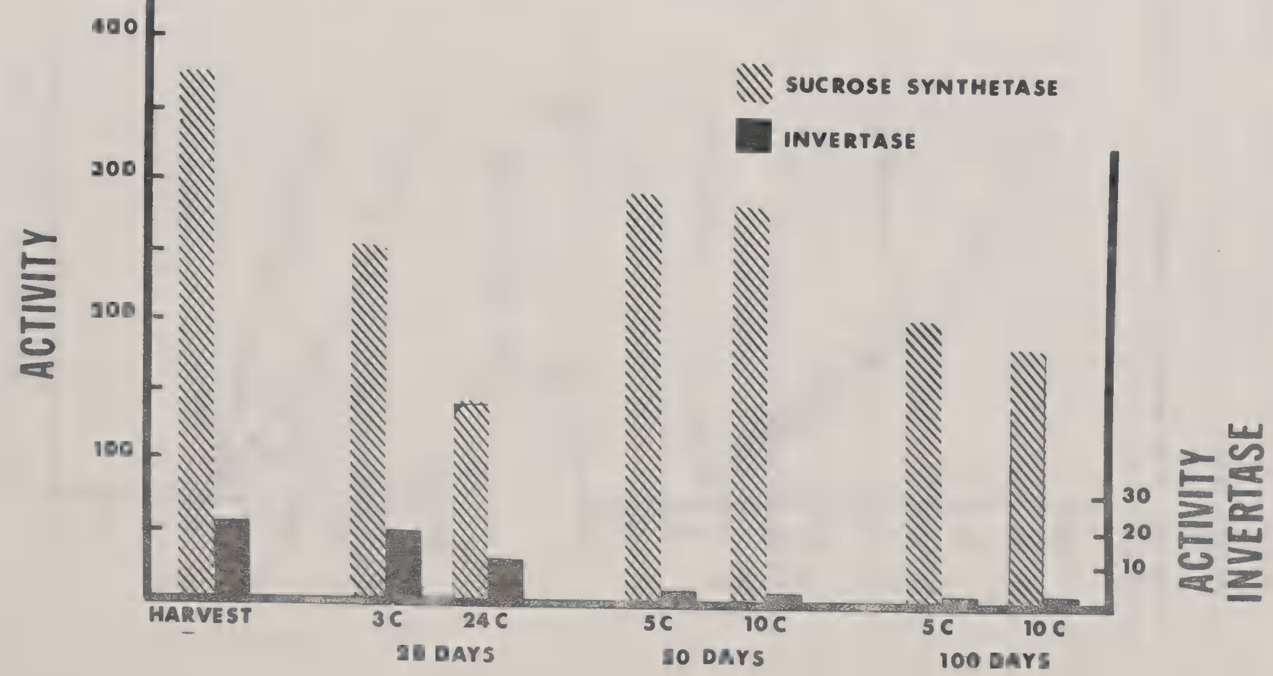


Figure 2

Sucrose Synthetase and Invertase activities in sugar beet roots under various storage conditions



Neutral Invertase Activity in Sugarbeet Roots

Roger Wyse

Many plants which store sucrose exhibit invertase activity with an alkaline pH optimum (Hatch, 1963) (Ricardo, 1970). Since neither acid invertase nor sucrose synthetase activity correlated with the accumulation of reducing sugars, attempts were made to determine if an alkaline invertase was present in sugarbeet.

MATERIALS AND METHODS

Isolation

Extracts were prepared from fresh or stored roots by blending 50 gm of peeled and grated root tissue with 50 ml of grinding buffer (5×10^{-2} M PO_4, 1×10^{-3} M mercaptoethanol, 1×10^{-2} M $NaSO_3$, 1×10^{-3} M EDTA, pH 7.5) for 1 min at medium speed in a Virtis homogenizer. The homogenate was filtered through 2 layers of cheesecloth and centrifuged at 27,000 xg for 20 min. The supernant was then dialyzed overnight against the grinding buffer. All procedures were carried out at 0-5 C.

Assay

Assays were performed using .15 ml assay buffer (1×10^{-2} M PO_4, 1×10^{-3} M EDTA, 5×10^{-1} sucrose at the proper pH) and .05 ml dialyzed extract. The assays were incubated for 20 min at 37 C. The reaction was stopped by the addition of 1 ml of Nelson's copper reagent. The reducing sugars produced were determined by the method of Nelson (1944) and protein by the method of Lowry (1951). Units of enzyme activity are expressed as mμm of reducing sugars produced per min per mg of protein under the assay conditions described above.

RESULTS

Assays for sucrose hydrolyzing activity from pH 5-8 indicated a peak of activity near pH 7 (Figure 1). This activity was present in both fresh and stored roots (1-2 months) at approximately equal activity (40-50 units). Results of substrate specificity experiments showed activity on raffinose and sucrose but not on maltose or melezitose which is consistent with the substrate specificity of a β-fructofuranosidase or invertase enzyme (Table 1).

Table 1. Substrate specificity of sucrose hydrolyzing activity at pH 7.0

Substrate	Activity (Relative)
Sucrose	100
Raffinose	8
Maltose	0
Melezitose	0

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Hatch, M. D., J. A. Sacher and K. T. Glasziou. 1963. Sugar accumulation cycle in sugar cane. I. Studies on enzymes of the cycle. Plant Physiol. 38:338-343.

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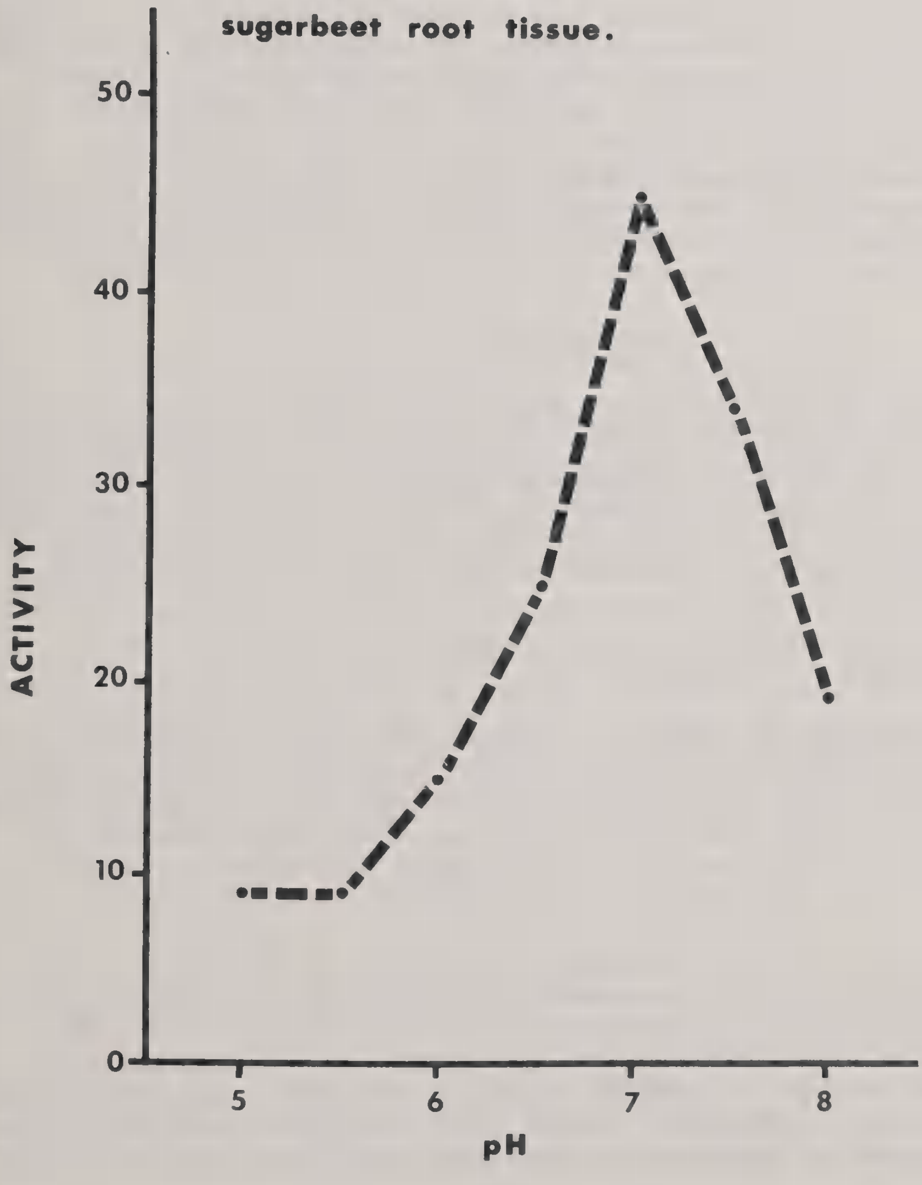
Ricardo, C. P. P., and T. ap Rees. 1970. Invertase activity during the development of carrot roots. Phytochemistry 9:239-247.

fig 1. Effect of pH on sucrose hydrolyzing activity in sugarbeet root tissue.



Procedure for Inducing Curly Top Epidemics in Field Plots

D. L. Mumford

For approximately 40 years plots of sugarbeets have been grown in the field under conditions favorable for evaluating resistance to curly top virus. Selections from these plots over the years have been used as parental material for nearly all cultivars of sugarbeets grown in states west of the Rocky Mountains. Until 1962 evaluations for curly top resistance were carried out in southern Idaho under the direction of Albert Murphy. In 1962 this work was moved to Utah and plots were established near Thatcher, about 40 miles west of the Logan laboratory. Disease evaluations were made at the Thatcher location until 1969. During this period, natural movement of leafhoppers was relied upon to obtain disease development in the plots. Also during this time it became apparent that natural movement of leafhoppers would not provide satisfactory disease development each year and, in fact, might seldom be sufficient to evaluate the more resistant selections presently needing evaluation. Therefore, in 1969 the evaluation work was moved to a location 5 miles north of the Logan laboratory and procedures were developed for producing curly top epidemics artificially.

PROCEDURES

In 1942 Murphy (1) outlined various methods of inducing curly top epidemics in the field. Utilizing the method he mentioned of releasing viruliferous leafhoppers, procedures have been developed since 1969 that appear to assure successful curly top epidemics in the field nearly every year. The procedures used the past 2 years have resulted in very favorable disease levels for evaluation and suggest that the results can be reproduced in succeeding years. Figure 1 outlines the schedule of events now being followed to induce curly top epidemics in field plots.

As indicated in Figure 1, preparations begin on December 1, in order to have 40,000 leafhoppers reared and 150 virus source plants with good symptoms by June 24. Approximately 250 sq. ft. of greenhouse bench space is required. Experience has shown that following the schedule quite close and having conditions favorable for both plants and insects are important to the success of the entire procedure.

The disease plot is deliberately planted late so that weather conditions will be most favorable for release of leafhoppers. The warm dry weather in this area when the plot is planted makes it essential to have sprinkler irrigation available during the emergence period. With such irrigation, emergence is usually excellent and early growth is rapid. Thinning is done while the beets are small so leafhoppers can be released before the seedlings become more resistant with age.

Methods of leafhopper release and subsequent movement are important factors in uniform development of symptoms throughout the plot. For this reason, the leafhoppers are divided into groups of 100 per leaf-cage for virus acquisition. These groups of 100 hoppers are released at two locations (approximately 6 feet in from each end of a 20-foot row) in each row. This is accomplished by walking across the rows at a right angle to row length and uniformly releasing hoppers from each 100 hopper leaf-cage over a predetermined distance. For 4 successive days after hopper release, a 12-foot length of aluminum tubing with heavy 2-3 foot rag strips hanging from it is carried over the rows in such a way that the rag strips drag over the plants and move the hoppers to new plants. Two such trips are made throughout the plot each day.

Observation indicates that the leafhoppers move very short distances during the 3-4 weeks they are in the plot. Before the above mentioned methods of releasing and scattering the leafhoppers were employed, areas 10-20 feet in diameter where a large group of hoppers were accidentally released would have unusually severe symptoms distinct from the remainder of the plot. This suggests that the leafhoppers fed on and inoculated plants primarily in the immediate area of release.

To check on uniformity of infection, every 10th row in the plot is a check row. A relatively susceptible cultivar, US 33, and a relatively resistant one, US 41, are alternated as these check rows. These checks also serve as a guide when evaluations are being made and as a standard of comparison with different entries from year to year. In the 1972 curly top plot 54 of the 83 rows of US 33 throughout the plot received a grade of 6 on a 0-9 scale. Of the remaining 29 rows, 28 received either grade 5 or 7. This indicates the good uniformity of infection over the entire nursery.

Figure 2 illustrates the differences between resistant and very susceptible entries observable in the 1972 disease plot. When differences such as these are obtained, it not only increases the reliability of the evaluations, but reduces the possibility of selecting plants that have simply escaped infection when individual plant selections need to be made from a particular row.

DISCUSSION

There are several advantages with the present method of inducing curly top epidemics rather than depending on natural leafhopper movements. The location of the plot is not restricted to near desert areas. The virus strain used for inoculation can be controlled. The period of time during which infection occurs is reduced. This last advantage is of considerable importance when evaluations for resistance are made. The time of infection influences greatly the severity of symptoms on

which the plants are graded. Therefore, if nearly all plants can be infected during a 1-2 week period as probably occurs with these procedures, then evaluations are more accurate than if plants are becoming infected throughout the growing season.

LITERATURE CITED

Murphy, Albert M. 1942. Production of heavy curly-top exposures in sugar-beet breeding fields. Proc. Am. Soc. Sugar Beet Technol. 3:459-462.

Figure 1. Schedule of events for inducing curly top epidemics in field plots[1]

December 1	Plant enough US 33 seed to obtain 20 seedlings for starting reproduction cages on February 1.
February 1	Start 15 reproduction cages with 50 adult leafhoppers per cage. Plant enough US 33 seed to obtain 140 plants for starting reproduction cages on April 1.
April 1	Start 110 reproduction cages with 50 adult hoppers per cage. Plant enough seed of US 33 to obtain 200 plants to inoculate as virus source plants.
April 10	Inoculate 10 US 33 plants (age 8 weeks) with virus to use as source on May 24.
May 24	Put 1200 hoppers on virus infected US 33 plants to inoculate virus source plants on June 1.
June 1	Inoculate 200 US 33 plants with 5 hoppers per plant for virus source plants to be used on June 24. Plant plots - keep moist with sprinkler system until emergence is satisfactory.
June 24	Put 40,000 hoppers on the 150 best virus source plants at the rate of 100 hoppers in each of 400 leaf-cages.
June 26-30	Cultivate and thin plots to approximately 20 plants per 20 ft. row.
July 1-2	Sprinkle plots.
July 6	Release 40,000 viruliferous hoppers (100 hoppers per leaf-cage) uniformly over plots.
July 7,8 9,10	Disperse hoppers on plots twice daily.
August 1	Spray plots thoroughly with Malathion or Parathion to kill all hoppers. Repeat if necessary.
August 10-15	Record curly top grade for each row
Sept. 10-15	" " " " "

[1] This schedule is geared to a 2.5 acre plot containing approximately 2000 20-foot rows.

Figure 2. Resistant and susceptible entries in 1972 curly top plot. Nearly all plants are dead in the two rows on either side of the center. Rows adjacent to these susceptible rows show different degrees of resistance. The far row to the right is US 33.

SUGARBEET RESEARCH

1972 Report

Section D

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Great Western Sugar Company
Holly Sugar Corporation
Spreckels Sugar Division
New Mexico Agricultural Experiment Station

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CONTENTS

SUMMARY OF ACCOMPLISHMENTS, 1972

Rhizoctonia Resistance Research, 1972

From a genetic analysis of disease indices of one Rhizoctonia susceptible and two resistant parents, and various segregating generations from crosses among the parents, we propose that in these populations there are three gene loci conditioning resistance to Rhizoctonia root and crown rot. Dominance and epistasis also are likely to be functioning in the genetic system. It is our general conclusion that developing high levels of Rhizoctonia resistance is possible but not without considerable effort, time, and expense. It appears that breeding methods involving progeny evaluations would likely be more efficient in improving resistance than mass selection.

From a preliminary study of the effectiveness of backcrossing to transfer Rhizoctonia resistance into susceptible sugarbeet lines, it is apparent that one cycle of phenotypic selection in each backcross generation will not be adequate to achieve a complete transfer of resistance. Considering these preliminary results, the relatively complex inheritance of resistance, and the environmental influence on disease expression, the transfer of resistance by backcrossing is likely to be difficult and slow, but not impossible.

In a disease free comparison of 40 experimental hybrids, their five Rhizoctonia resistant pollinators, and four checks, the hybrids were not superior in any case to the adapted commercial hybrid check. However, both parents of all these hybrids came from the Rhizoctonia and leaf spot-curly top resistance breeding programs where disease resistance rather than root yield combining ability had been emphasized. The experimental hybrids were generally equal to the check for sucrose content and purity but generally demonstrated considerably less heterosis for root yield. Under intense leaf spot or Rhizoctonia infection certain of these experimental hybrids have demonstrated superior sugar production over commercial checks.

Genetic and Breeding Studies

A predominance of additive genetic variance was found for the nonsucrose sugarbeet constituents, sodium, potassium, betaine, amino nitrogen, nitrate nitrogen, and total nitrogen. Results indicated that breeding for lower quantity of all these nonsucrose components, except betaine, would best be done in a high N environment. Improvement of betaine levels can likely be achieved under a wide range of N levels.

The relative importance of the three basic variables affecting recoverable sugar in sugarbeet (root weight, sucrose %, and purity%), was found to be different in improved sugarbeet populations as compared to unimproved populations. Results suggest that the emphasis of breeding programs will need to change with changes in the genetic structure of the improved population.

Recent results along with previous study indicated that 30-40% of the variance in leaf spot resistance is environmental, 36-47% is due to nonadditive genetic variance and 20-25% is due to the additive component of genetic variance.

Development and Evaluation of Breeding Material with Resistance to Leaf Spot and Curly Top

Twenty-six lines tested for *Cercospora* leaf spot resistance at Fort Collins and for curly top resistance at Logan, Utah had high resistance to both diseases. The 26 lines ranged from 43 to 78% of US 41 for curly top resistance and had leaf spot readings of 2.0-3.0 on a 0-10 leaf spot scale. Fourteen top crosses with seven different pollinators from a group of 64 entries gave curly top readings of 74-85% of US 41 in field tests at Logan, Utah.

Numerous sugar company lines were evaluated for resistance to *Cercospora* leaf spot under field conditions. The leaf spot epidemic developed slowly due to cool nights following inoculation. The epidemic did reach a satisfactory level by September 1, 1972.

General combining ability of five disease resistant pollinators was inversely related to per se performance for root weight. Per se performance for sucrose and purity compared very favorable with the actual GCA estimates for the five common female lines in the test.

Relation of Sugarbeet Quality Characteristics and Methods of Sample Preparation and Storage

Fifty-five sugarbeet samples of 20 lbs each were harvested from diverse genotypes and environments. Juice extracts were prepared from each brei sample by six methods: Two extracts were prepared and analyzed immediately, one with and one without the preservative PMA; the same two extracts were frozen for 10 days before analysis; and two extracts were prepared, one with and one without PMA, from brei which had been frozen for two weeks. Brei sucrose (before and after freezing), thin juice purity, and extract sucrose, RDS, and purity were determined. Also determined were the seven nonsucrose components: conductivity ash, total N, amino N, NO_3, Cl, Na, and K, and computed as % based on 100

sucrose in extract. Statistical analyses of the data showed: (1) brei sucrose was not significantly changed by freezing, (2) there was no significant difference between extracts prepared with and without PMA, (3) the two frozen extracts' means showed a significant difference from those of the fresh extracts for most components measured. The extracts prepared from frozen brei showed a significant difference in total N only, (4) a stepwise regression analysis showed sodium and potassium, respectively, most highly correlated with % sucrose, but conductivity ash and amino N showed the highest correlation to purity.

RHIZOCTONIA RESISTANCE RESEARCH, 1972

Field studies of Rhizoctonia root and crown rot (*R. solani*) of sugarbeet were conducted at our disease nursery (Warren tract) near the Colorado State University Agronomy Research Center, Fort Collins. The following experiments, in addition to selection areas, were included in the Rhizoctonia field:

1R	Side dress versus rosette inoculation
2R	Rhizoc. evaluation of regional coop test
3R	Rhizoc. resistance inheritance and backcross study
5R	Rhizoc. evaluation of breeding lines
7R	Rhizoc. evaluation of BSDF contributed lines
8R	Rhizoc. evaluation of progeny lines

Except for experiment 3R and the selection areas, a side-dress inoculation technique was used in 1972. This method of Rhizoctonia inoculation (3 weeks post thinning) was equally as effective as the rosette inoculation method in experiments conducted in 1970 and 1971. However, in 1972 this side-dress inoculation failed to induce an adequate root rot epidemic. Reasons for the failure of the epidemic to develop are not easily explained. Since the inoculum was known to be highly pathogenic in the greenhouse and in experiment 3R, its virulence is not in question. We believe, therefore, that adverse weather conditions contributed primarily to the mild epidemic. Rhizoctonia root rot develops best under warm temperatures. The subnormal day and night temperatures that prevailed at inoculation and, indeed, through most of July and early August undoubtedly restricted fungus growth in the soil. The beets, however, grew well during this period and probably attained some mature-plant resistance before the pathogen was able to invade the roots.

Conversely, inoculum placed in the crown of beets (rosette method) in experiment 3R and the selection areas was able to penetrate and infect the plants immediately and a severe epidemic ensued. Until additional data are obtained on inoculation technique x environment interactions, the rosette inoculation method will be used in future field tests. From our experience we can only recommend the rosette method as a reliable Rhizoctonia inoculation technique (one-sixth teaspoon of dry, ground, barley-grain inoculum per plant, placed in the center of the foliar rosette approximately 3 weeks post thinning).

In experiments 1R, 2R, 5R, 7R, and 8R there was insufficient infection to distinguish genotype differences in resistance to Rhizoctonia. Therefore, no results for these experiments will be reported.

<u>Rhizoctonia Resistance Inheritance Study</u> by R. J. Hecker and E. G. Ruppel

Experiment 3R, 1972, included a number of populations which had been developed to further study the inheritance of resistance to Rhizoctonia root and crown rot in sugarbeet. Inheritance information would be of considerable value in breeding for resistance.

The entries listed in Table 1 were grown in a randomized complete block experiment, 12 replications, 20-ft single row plots (22-in apart), planted May 15, thinned June 14, rosette inoculated July 13, and dug and rated on an individual plant basis September 19. Infection and the epidemic were very satisfactory. Disease index (DI) ratings were based on a scale of 0 (completely healthy) to 7 (dead).

Total within plot variances of disease index were calculated from the frequency distributions and are tabulated in Table 1. Total genetic variances were estimated for the F_1's and segregating populations by using the mean total within plot variance of the three parents (P_1, P_2, and P_3) as an estimate of the environmental variance. From studying the frequency distributions it was apparent that there was some heterozygosity in the resistant parents (P_2 and P_3). Therefore the estimated genetic variances should be somewhat conservative. All heritabilities (h^2) were estimated, but the most meaningful h^2's are for the two F_2's (entries 703 and 704). These broad sense h^2's (.47 and .46) were relatively high and compare with .27 and .30 in the 1970 inheritance study.

The frequency distributions were examined and attempts were made to find obtained classifications in the segregating populations which fit the classical ratios (3:1, 1:1, 9:3:3:1, etc). None fit satisfactorily. From further study of the frequency distributions it was apparent that P_1 (Rh. susc. parent) was relatively homozygous, 81% rated 7, and only 2.8% collectively rated 0, 1, and 2. P_2 and P_3 (Rh. resistant parents) obviously were not homozygous for resistance, 4% and 12% in class 7, respectively. Obtained segregation ratios adjusted for P_2 and P_3 heterozygosity still failed to fit classical expected ratios. Testing of specific genetic models was then tried. There are, of course, an infinite number of possible models, but from examination of obtained means, frequency distributions, and variances, the most probable genetic hypotheses were developed. Certain factors about the obtained data made the formulation of genetic hypotheses very difficult, i.e., P_2 and P_3 means of 1.4 and 2.2; F_1 means of 4.3 and 3.4 (slightly recessive for resistance versus dominance). Some of the results were not quite consistent with the preliminary inheritance study of 1970 (Sugarbeet Research, 1970 Report). However, the disease intensity and uniformity of infection was more satisfactory in 1972; therefore, the 1972 data are considered better for development and testing genetic hypotheses.

Numerous genetic models and variations within models were tested comparing theoretic means and genetic variances with obtained means and

genetic variances. Two locus models did not account for the differences between the three parents (P_1, P_2, and P_3). The three locus model in Table 2 was the model which provided the best fit to obtained data. In general this best model did not provide an entirely satisfactory fit to the obtained data. The theoretic means of $P_1 \times P_2$, F_1 and $P_1 \times P_3$, F_1 were the only means which differed from obtained means. Hence, the genotypes proposed in the model for P_1, P_2, and/or P_3 were not exactly right, or else the gene frequencies proposed for P_2 and P_3 were slightly incorrect. There were also some differences between obtained and theoretic genetic variances, particularly for P_2 and $P_1 \times P_2$, F_1. But it appears that the models as proposed in Table 2 do approximate the actual genetic control of Rhizoctonia resistance in FC 701/3, FC 702/3, and FC 901. The genetic models proposed in the 1970 study are not greatly different than those proposed this year in Table 2. We had proposed allelic differences between FC 701/3 and FC 702/3 in 1970. This year we propose locus differences between these two resistant parents. We think the locus difference is probably more nearly accurate. Therefore, we are proposing that there are three gene loci conditioning resistance. FC 701/3 and FC 702/3 are probably each heterozygous for two loci (FC 701/3 is heterozygous for A and B; FC 702/3 is heterozygous for A and C). Assuming we have essentially described the true genetic situation, there still are probably some modifying genes or some specific epistatic interactions which directly affect Rhizoctonia resistance.

From these results and breeding experience it can be assumed that developing high levels of Rhizoctonia resistance in adapted materials or backcross incorporation of resistance into parent lines of hybrids is possible but not without considerable effort, time, and expense. It would appear that breeding methods involving progeny testing for resistance would be more efficient in improving resistance than mass selection. Any resistance breeding program will at this point in time require a field evaluation program with close control in a well managed disease nursery.

Our breeding program currently involves simultaneous improvement of Rhizoctonia resistance and general combining ability of the FC 701 and FC 702 series for potential use as pollinators. We are continuing to study the degree to which we may be able to capitalize on dominance for resistance. We are also developing mono, type-O lines with resistance, and have started a program to develop resistance in SP 6322-0 (a widely used pollinator in commercial hybrids).

Table 1. Disease indices (DI, 0 = no disease, to 7 = dead) of parents, F_1's, segregating populations, and checks for study of inheritance of Rhizoctonia resistance.

Entry no.	Population	Obtained DI[1/]	Midpar. DI[2/]	Total within plot var.	Total genetic var.	Broad sense heritability(h_2)
697	P_1;(FC 901 Rh.susc.)	6.4 a		1.94		
698	P_2;(FC 701/3 Rh.resist.)	1.4 f		2.97		
699	P_3;(FC 702/3 Rh.resist.)	2.2 e		3.97		
700	P_1 x P_2, F_1	4.3 c	3.9	4.30	1.34	.31
701	P_1 x P_3, F_1	3.4 d	4.3	4.41	1.46	.33
703	P_1 x P_2, F_2	4.0 cd	3.9	5.59	2.63	.47
704	P_1 x P_3, F_2	3.9 cd	4.3	5.44	2.49	.46
705	P_3 x P_2, F_2	2.3 e	1.8	4.19	1.23	.29
706	P_1 x (P_1 x P_2, F_1)	5.5 b	5.2	3.15	.20	.06
707	P_1 x (P_1 x P_3, F_1)	5.2 b	5.4	3.24	.28	.09
717	GW 674-56C (Orig. of P_2)	5.5 b				
718	C 817 (Orig. of P_3)	5.2 b				

1/ Means followed by the same letter are not significantly different at the 5% level.

2/ Midparental values; assumes homozygous parents, only additive gene action, and no selection.

Table 2. Comparison of obtained and theoretic means and genetic variances for disease index in the Rhizoctonia resistance inheritance study, 1972.

Entry no.	Population	Mean DI Obtained	Mean DI Theoretic	Genetic variance Obtained	Genetic variance Theoretic
Model for P_1 (FC 901 Rh.susc.) and P_2 (FC 701/3 Rh.resist.):					
P_1 is aabbcc, DI = 6.4					
P_2 is heterozygous; frequency of a and b = .44, c = 1 (estimated from P_2 distribution)					
A is partially dominant for resistance; 1st A adds -2.7 and 2nd A adds -.5					
B is partially dominant for susceptibility, 1st B adds -.5 and 2nd B adds -2.7					
A and B are complimentary so that when together their genetic value is 0					
AABBCC assumed to have DI = 0					
698	P_2(FC 701/3 Rh.res.)	1.4±.11	1.5	2.97	6.29
700	P_1 x P_2, F_1	4.3±.14	3.6	4.30	6.92
703	P_1 x P_2, F_2	4.0±.14	4.0	5.59	6.05
706	P_1 x (P_1 x P_2, F_1)	5.5±.12	5.3	3.15	3.42
Model for P_1 and P_3 (FC 702/3 Rh.resist.):					
P_1 is aabbcc, DI = 6.4					
P_3 is heterozygous; frequency of a and c = .59, b = 1 (estimated from the P_3 distribution)					
A is partially dominant for resistance; 1st A adds -2.7 and 2nd A adds -.5					
C is completely dominant for resistance; 1st C adds -3.2					
A and C are complimentary so that when together their genetic value is 0					
AABBCC assumed to have DI = 0					
699	P_3	2.2±.13	2.3	3.97	4.85
701	P_1 x P_3, F_1	3.4±.14	3.9	4.41	4.84
704	P_1 x P_3, F_2	3.9±.16	4.1	5.44	4.63
707	P_1 x (P_1 x P_3, F_1)	5.2±.13	5.2	3.24	3.06
Model for P_2 (Rh.resist.) and P_3 (Rh.resist.):					
P_2 is heterozygous for a and b; frequencies = .44 Homozygous for c					
P_3 is heterozygous for a and c; frequencies = .59 Homozygous for b					
Same dominance and complimentation as specified above for crosses with P_1					
705	P_3 x P_2, F_2	2.3±.13	2.1	4.19	5.39

<u>Rhizoctonia Resistance by Backcrossing Breeding</u> by R. J. Hecker and E. G. Ruppel

The backcross (BC) method of breeding should theoretically provide a precise way of incorporating Rhizoctonia resistance into proven parents of hybrids, varieties, etc. The effectiveness of the method is directly related to the effectiveness of selecting the resistant genotypes in each backcross generation.

We know from the inheritance study that Rhizoctonia resistance is probably conditioned by more than one gene locus and that chance or environment (escapism, etc.) may have considerable effect on the disease expression of individual plants. Therefore, we would expect some difficulty in transferring Rhizoctonia resistance by backcrossing, particularly a transfer without some diminution of resistance.

In Experiment 3R, 1972, we had included six backcross populations which have provided some preliminary data on the transfer of Rhizoctonia resistance by backcrossing. Materials and methods were described in the preceding inheritance study. Table 1 lists the populations and disease index means.

Each of the six BC populations (711-716) had one cycle of selection for Rhizoctonia resistance. In the case of the BC_1's 711-714, selection was done in the F_2. In the BC_2's 715-716, selection was done in the BC_1 generation. It is quite obvious that one cycle of selection in each backcross generation will not be adequate to achieve a complete transfer of Rhizoctonia resistance. In BC_1's 712 and 714, selection led to no greater resistance than the random backcross, 707. Entry 713 was the only backcross population which showed a marked response to the selection for Rhizoctonia resistance. However, all six BC's with one generation of selection (711-716) had slightly lower disease indices than expected with no selection. It does not appear that the open pollination of BC_1's 711 and 712 had any effect on resistance. Also, it appears that one cycle of selection in the F_2 is likely to be only slightly more effective than one cycle of selection done in the BC_1. The BC_2's (715 and 716) with one cycle of selection are only slightly more resistant than expected with no selection.

Considering the relatively complex inheritance of Rhizoctonia resistance and possible environmental influence on disease expression, the transfer of Rhizoctonia resistance by backcrossing is likely to be difficult and slow. It would probably be necessary to make two or three cycles of mass or mother-line selection for resistance in each backcross generation. It might be possible to backcross without selection, and then practice intense selection for resistance in an advance backcross. But, there would be considerable risk that this intense final selection might genetically alter the population with a loss of desirable characteristics of the recurrent parent.

Table 1. Disease indices (DI) for Rhizoctonia resistance of parents, backcrosses, and checks (Experiment 3R, 1972).

Entry	Population	Obtained DI[1/]	DI Expected no sel.[2/]
697	P_1;(FC 901;Rh.susc.)	6.4 a	
698	P_2;(FC 701/3;Rh.res.)	1.4 f	
699	P_3;(FC 702/3;Rh.res.)	2.2 e	
706	P_1 x (P_1 x P_2,F_1)	5.5 b	5.2
707	P_1 x (P_1 x P_3,F_1)	5.2 b	5.4
711	[P_1 x (P_1 x P_2,F_2;Rh.sel.)] OP_1	5.1 bc	5.2
712	[P_1 x (P_1 x P_3,F_2;Rh.sel.)] OP_1	5.2 b	5.4
713	P_1 x (P_1 x P_2,F_2;Rh.sel.)	4.5 c	5.2
714	P_1 x (P_1 x P_3,F_2;Rh.sel.)	5.2 b	5.4
715	P_1 x [P_1 x (P_1 x P_2,F_1);Rh.sel.]	5.6 b	5.8
716	P_1 x [P_1 x (P_1 x P_3,F_1);Rh.sel.]	5.7 b	5.9
700	P_1 x P_2, F_1	4.3 c	
701	P_1 x P_3, F_1	3.4 d	
703	P_1 x P_2, F_2	4.0 cd	
704	P_1 x P_3, F_2	3.9 cd	
717	GW 674-56C (Orig. source of P_2)	5.5 b	
718	C 817 (Orig. source of P_3)	5.2 b	

1/ DI on a scale of 0 to 7 with 0 = healthy and 7 = dead. Means followed by the same letter are not significantly different at the 5% level.

2/ Midparental values; assumes homozygous parents, additive gene action, and no selection.

Comparison of Hybrids Involving Rhizoctonia Resistant Pollinators by R. J. Hecker, G. A. Smith, and E. G. Ruppel

Forty experimental hybrids involving 12 male sterile female lines (from our leaf spot-curly top resistance breeding program) and five pollinators (from our Rhizoctonia resistance breeding program) were compared in 1972 for four yield characteristics. Four checks and the five pollinators were also included for a total of 49 entries. They were grown disease free at the Colorado State University Agronomy Research Center in a 7 x 7 triple lattice (9 replications) with 20-ft single row plots. The test was planted April 11 and harvested October 5. One hundred pounds of actual nitrogen was applied as ammonium nitrate.

The five pollinators resulted from intense selection for Rhizoctonia resistance with little selection for combining ability or per se performance. Means for the most superior hybrids are shown in Table 1 along with the checks and pollinators.

Table 1. Means for selected hybrids, four checks, and five pollinators for root weight, sucrose, purity, and recoverable sugar, 1972.[1/]

Entry	Root wt. (kg/plot)	Sucrose (%)	Purity (%)	Recov.sug. (kg/plot)
662119s1 x FC 703	15.8	18.4	95.6	2.65
662119s1 x FC 701/2	14.8-	18.4	95.3	2.46-
(FC 603 x 662119s1) x FC 703	15.2-	18.1	94.9	2.47-
(FC 603 x 662119s1) x FC 801	15.6	17.7-	94.4	2.45-
(FC 603 x 662119s1) x 711245HOO	15.8	18.1	94.7	2.53-
681205HOO x FC 702/2	14.0-	19.3+	95.1	2.44-
(FC 504 x FC 502/2) x FC 703	13.4-	19.0	95.1	2.29-
662125s1 x FC 702/2	13.3-	18.8	96.4+	2.31-
Mean of 8 ♀'s x FC 701/2	13.6-	18.3	94.6	2.22-
Mean of same 8 ♀'s x FC 702/2	13.6-	18.7	94.9	2.28-
Checks and pollinators				
GW Mono Hi A1 (Check)	16.6	18.6	94.5	2.74
US H20	15.8	17.5	94.3	2.46-
GW 674-56C	13.0-	17.7-	94.3	2.03-
FC 506 CMS x FC 902	14.1-	18.1	94.0	2.24
FC 701/2	10.9-	18.1	94.1	1.74-
FC 702/2	10.9-	18.4	94.0	1.76-
FC 703	11.4-	18.5	94.7	2.24-
FC 801	12.6-	18.0-	94.5	2.02-
711245HOO	12.4-	17.9-	94.9	1.99-

[1/] + following a mean indicates significant superiority (5% level) to the check GW Mono Hi A1; - indicates significant inferiority; no sign indicates no significant difference from the check.

It is obvious from Table 1 that the experimental hybrids were not as good as the check, GW Mono Hi A1. This check is the hybrid variety grown commercially in this area. There were no experimental hybrids superior to the check for root yield, only one superior for sucrose, only one superior for purity, and none superior for recoverable sugar. For recoverable sugar there was only one hybrid which was not different than the check; all others were significantly inferior. This is not too surprising, since disease resistance has of necessity received the greatest emphasis in the development of both the females and the pollinators. Combining ability for root yield is where the check has shown its superiority in this disease-free test. In other tests, under intense leaf spot infection or Rhizoctonia infection, certain of these experimental hybrids have demonstrated unquestionable superiority.

SUGARBEET DISEASE INVESTIGATIONS, 1972

E. G. Ruppel

The following are brief summaries of research conducted in 1972. In most cases, sufficient data are not available for detailed presentation of results at this time. Results, therefore, should be considered tentative until confirmatory data are obtained.

Rhizoctonia Root Rot

Soil composition and texture.--Sugarbeet cultivars FC 701/2 (root rot resistant) and GW 674-56C (susceptible) were grown in various mixtures of a heavy clay soil and peat moss or sand. Percentages of peat or sand varied from 0 to 75% (v/v). Soil mixes initially were fertilized with slow-release pellets, and all pots were irrigated weekly with a liquid fertilizer. The soil in each pot was infested with dry, ground, barley-grain inoculum of *Rhizoctonia solani* when plants were 3 months old. Roots were evaluated for rot 30 days after inoculation. Severity of root rot was essentially similar in all clay-peat mixtures. With clay-sand mixes, however, there was a tendency toward increased root rot severity with an increase in sand content.

Plant age at inoculation.--Cultivars FC 701/2 and GW 674-56C were inoculated with *R. solani* at 2, 4, 8, 12, and 16 weeks of age. Dry, ground, barley-grain inoculum was placed 2 cm deep in the soil about 2 cm from each tap root. In two tests with five replications per test, root rot was most severe in beets inoculated at 8, 12, and 16 weeks of age regardless of cultivar. Differences between cultivars were highly significant at the older ages, with severity being greater in GW 674-56C at all ages. The apparent resistance exhibited by 2- and 4-week-old plants contrasts with the lack of resistance normally seen in seedlings of any cultivar when planted in Rhizoctonia-infested soil.

Inoculum potential.--Dry, ground, barley-grain inoculum was added to steamed soil to give concentrations of 1000, 2800, 8000, 22,600, and 64,000 ppm inoculum (dry weight basis). Seeds of resistant cultivar FC 701/5 and susceptible GW 674-56C were planted in each mixture. Controls consisted of seeds planted in sterilized soil containing 64,000 ppm of autoclaved grain inoculum. Damping-off as a percentage of control survival was directly proportional to the amount of inoculum in the soil from 2800 to 64,000 ppm. Damping-off in soil at 1000 ppm inoculum was equal to that recorded in soil having 8000 ppm. Differences between cultivars were evident at all concentrations up to 22,600 ppm, with more damping-off occurring in GW 674-56C.

Isolate differentiation.--A crown, foliar, and root isolate of *R. solani* from sugarbeet, and a stem isolate from potato were grown in Czapek's dox broth for 2 weeks. Free amino acids were extracted from

the cell-free medium, and from sonically homogenized mycelial pads and analyzed in an amino acid analyzer. Differences among isolates were detected in the amounts of several amino acids recovered from mycelium. Generally, the faster growing crown and foliar isolates yielded significantly greater amounts of most amino acids on a dry weight basis than did the root and stem isolates. (This study is being conducted in cooperation with Grace Maag, Research Chemist.)

Longevity of inoculum.--Dry, ground, barley-grain inocula of *R. solani* (RR-9) prepared for field studies yearly from 1960 through 1966, 1968, and 1971 have been stored in a refrigerator at 2-3 C. (Inoculum from 1967, 1969, and 1970 was exhausted in field studies.) Viability of each year's inoculum was tested on a *Rhizoctonia*-selective medium. Average number of colonies per plate was: 1960, 0; 1961, 5; 1962, 2; 1963, 1; 1964, 10; 1965, 3; 1966, 5; 1968, 1; 1971, 17. Ability to incite damping-off was tested by planting sugarbeet seeds in infested soil. Average percentage damping-off was: 1960, 19; 1961, 90; 1962, 78; 1963, 17; 1964, 97; 1965, 67; 1966, 56; 1968, 13; 1971, 100. The ability to induce root rot was tested by placing inoculum in the crowns of 8-week-old sugarbeets. Plants were kept in a humidity chamber for 5 days. Average root rot severity 30 days after inoculation (scale of 0 to 5, with 0 = no rot and 5 = 100% rot) was: 1960, 1.0; 1961, 2.0; 1962, 4.3; 1963, 0.8; 1964, 3.3; 1965, 3.0; 1966, 1.8; 1968, 0.3; 1971, 3.0. Viability and pathogenicity were not associated with age of inoculum. Pathogenicity (or virulence), however, was associated with viability. These results, and those of the inoculum potential study (3, above) demonstrate the relationship between root rot severity and concentration of the pathogen in soil.

Cercospora Leaf Spot

Cultural and pathogenicity comparisons of several new isolates of *Cercospora beticola* with other isolates on hand were conducted. Some cultural differences were noted, but all isolates behaved similarly in resistant and susceptible cultivars without significant isolates X lines interactions.

Alternaria Leaf Spot

A serious foliage blight was observed in a portion of our Rhizoctonia breeding nursery. Disease symptoms and isolations of *Alternaria brassicae* indicated that the disease was Alternaria leaf spot, first described by McFarlane et al. [J. Amer. Soc. Sugar Beet Technol. 8(Part 1):241-246, 1954] from California. Although the disease was more severe in certain inbred lines, some hybrids also were affected. Both *Rhizoctonia*-inoculated and noninoculated plants were similarly affected indicating that root rot did not predispose the beets to leaf spot. The disease apparently was limited to the Rhizoctonia nursery. No Alternaria leaf spot was observed in our Cercospora nursery, which was located only 90 m west, or in sugarbeets on the CSU Agronomy farm or a commercial field (400 to 800 m north).

GENETIC AND BREEDING STUDIES, 1972

Genetic Control of Nonsucrose Components by G. A. Smith and R. J. Hecker

It is well known that the processing impurity components or soluble nonsucrose constituents in sugarbeets impede crystallization and, hence, lower extraction of sucrose. Potassium, sodium, amino acid nitrogen, and betaine are four melassogenic components that account for 80-90% of the refractometric nonsucrose constituents in second carbonation juice and are considered the most important nonsugar impurities with which the sugar processor is obliged to deal.

About the only conclusion which can be drawn from the literature is that the genetic control of the important nonsucrose components is probably quantitative. If the proper populations can be obtained, the diallel analysis can be used successfully to better understand the nature of gene action governing quantitative traits. We used the diallel analysis to determine (1) the relative importance of general and specific combining ability for each of six nonsucrose components, (2) the magnitude of genetic variance for additive and nonadditive gene action.

Results indicated a predominance of additive genetic variance for sodium, potassium, betaine, amino nitrogen, nitrate nitrogen, and total nitrogen. Heterosis for low betaine was found under low and high nitrogen levels. Our results indicate that breeding for lower quantity of all these nonsucrose components, except betaine, would best be done in a high N environment. Improvement of betaine levels can likely be achieved under a wide range of N levels.

Relationships of Yield Components in Random and Improved Sugarbeet Populations by G. A. Smith and R. J. Hecker

Complex characters such as yield are the end product of many factors which jointly or singly influence the end product. A desirable prerequisite for a plant breeder is to have information on the direct or indirect influence of these characters on yield. Wright (1921) developed a technique known as path-coefficient analysis by which the extent and nature of direct and indirect effects of the component characters can be understood. While there are many reports on correlation studies in sugarbeet, there has been no application of path-coefficient analyses in this crop.

Using this technique we have recently found evidence which suggests that the relative importance of the three basic variables affecting recoverable sugar (root weight, sucrose %, and purity%), is different in improved sugarbeet populations than in unimproved populations. Results suggest that the emphasis of breeding programs will need to change with changes in the genetic structure of the improved population.

We are currently applying the path-coefficient technique to thin juice purity %. Using sucrose % and the nonsucrose components of sodium, potassium, betaine, amino nitrogen, nitrate nitrogen, and total nitrogen as the independent variables, we expect to accurately rank the relative importance of these components to thin juice purity.

Photosynthetic Efficiency in Relation to Performance by G. A. Smith and R. J. Hecker

We are currently studying a leaf disc technique in the laboratory which may be used to determine net photosynthesis. We are studying from a breeding aspect the ability of the technique to differentiate photosynthetically efficient lines from less photosynthetically efficient lines. We intend to later study the relation of the laboratory results to actual field performance and combining ability.

The Heritability of Resistance to *Cercospora* Leaf Spot by G. A. Smith and E. G. Ruppel

We previously reported broadsense heritability estimates of 60 to 71% (see Smith and Gaskill, J. A.S.S.B.T., Vol 16, 1970). Current results from a 3 year study gave narrow sense heritability estimates of .243. These results were based on regression analysis of F_3 families on F_2 plants. Two resistant by susceptible crosses were used in the study. Parents in the study were inbred and homozygous for resistance or susceptibility. As part of the study, high and low selections were made for resistance in each of the two F_2 populations to serve as checks on the accuracy of heritability estimates obtained by regression. Heritability estimates of .267 and .205 were obtained for the two crosses after the F_3 populations were grown. These results agree well with the .243 values obtained by parent progeny regression. These results estimate the additive portion of the genetic variance plus a portion (somewhat less than half) of the epistatic variance. The results of this study agree well with the record of progress in breeding for resistance to *Cercospora* in various lines.

From this and our previous study we have determined that 30-40% of the variance in leaf spot resistance is environmental, 36-47% is due to nonadditive genetic variance and 20-25% is due to the additive component of genetic variance.

Ineffectiveness of Low Temperature Alone for Floral Induction of Sugarbeet Seed by R. J. Hecker and G. A. Smith

In attempting to reduce the labor and facilities necessary for photothermal induction, and to shorten the life cycle of sugarbeet, seed was treated as for germination, except it was held in darkness at 5 C for up to 90 days. After this vernalization the seed was planted into pots, and kept at 22 C under continuous light. Only one out of six varieties showed significant seed stalk development. This

variety was the only one which germinated and produced radicles during vernalization. Low temperature by itself apparently is not sufficient to induce floral development. It appears that some growth during vernalization is necessary, followed by relatively cool temperature and long photoperiod.

The facilities and labor required for photothermal induction of sugarbeet are rather extensive. A considerable saving of resources could be effected if sugarbeet seed could be induced to the flowering stage solely by thermal treatment. Previous vernalization experiments by others were confined to pregerminated seed, and it was found that the amount of bolting (seed stalk formation) was apparently related to: 1) the amount of growth of the seed prior to and during the cold treatment; and 2) the environment following vernalization. The objective of our experiments was to determine if sugarbeet seed could be induced to the reproductive stage solely by exposure to low temperature germination conditions.

In two separate experiments, each replicated four times, we treated 800 seed of six open pollinated and hybrid varieties, ranging from easy to hard bolting. The treatment consisted of a 3 minute surface sterilization in a 2% solution of sodium hypochlorite followed by a rinse. The seed was placed on blotters over a moisture retaining cotton matrix in plastic germination boxes, watered with a dilute solution of N-(ethylmercuri)-p-toluene sulfonanilide (a fungicide), and stored in the dark at 5 C for 30, 45, 60, and 90 days. Vernalization treatments were commenced at different dates so that all seed, along with untreated checks of each variety, could be planted at the same time in pots in the greenhouse. The plants were then kept in the greenhouse under a 24-hour photoperiod at about 22 C.

After 38 days of post induction growth there was 8 and 26% bolting of one relatively easy bolting variety, SP 5822-0, vernalized for 60 and 90 days, respectively. One bolting plant occurred in the hard bolting hybrid US H9B, which had been vernalized for 90 days. There was no other bolting in the two experiments. SP 5822-0 was the only variety which germinated and made significant growth during vernalization. It had grown radicles up to 2 cm during vernalization.

From our experiments it appears that low temperature treatment of sugarbeet seed is not sufficient by itself to induce bolting. Apparently some growth prior to or during vernalization is necessary, followed by relatively cool temperature and long photoperiod.

<u>General Combining Ability of Some Currently Used Pollinators</u> by G. A. Smith

The general combining ability (GCA) of six disease resistant pollinators was determined from crosses to five female lines. An incomplete

crossing system analysis as outlined by Milliken et al. was used to arrive at GCA estimates and confidence intervals. The per se performance of these same pollinators is presented in Table 1. Only pollinators included in the specific GCA test have reported GCA estimates and confidence intervals. The five common pollinators used in the crosses were; (1) (SP 632028s1 x FC 601) mm, (2) FC 506-CMS, mm, (3) FC(504 x 502/2)-CMS, (4) 642027s1-CMS, mm, (5) 662119s1-CMS, mm. Results of the GCA test are presented in Table 2.

In comparing Table 1 with Table 2, it can be seen that per se performance of the pollinator was not a good indicator of GCA for root weight. However, per se performance for sucrose and purity compared very favorable with the actual GCA estimates for the five common female lines in this test.

Table 1. Per se performance of some currently used disease resistant pollinators grown under disease free conditions. (Experiment 7, 1972).

Pollinator or variety	Root wt.kg	Sucrose %	Purity %
FC 701/2	13.56	18.08	92.86
FC 702/2	11.00	18.08	94.40
FC 701/5	12.83	17.60	92.79
FC 702/5	10.77	18.13	93.88
FC 901	12.79	17.50	93.99
FC 801	14.13	17.44	93.21
FC 703	11.89	18.26	94.23
FC 702/4	12.26	18.33	93.85
FC 902	11.80	17.66	93.83
FC 903	11.73	17.09	93.33
FC 904	13.30	17.74	94.31
6322-0	12.65	17.10	93.84
FC 504	7.94	16.51	93.00
FC 506	8.57	17.84	94.10
GW Mono Hi A-1	16.87	18.26	93.58
US H20	15.75	17.35	94.80
LSD(.05)	1.75	0.53	1.29
CV%	9.92	2.18	0.97

Table 2. The GCA estimates of seven disease resistant pollinators.[1]

Pollinator	Rt. wt.	GCA[2]	Sucrose %	GCA	Purity %	GCA	Recov. sugar	GCA
FC 702/2	12.67	-.656	18.59	.287	95.52	.270	2.14	-.057
FC 701/2	13.26	-.066	18.92	.608	94.79	-.467	2.24	.042
FC 901	13.68	.358	17.95	-.363	94.53	-.729	2.18	-.021
FC 801	12.77	-.552	17.87	-.438	95.17	-.084	2.05	-.151
FC 703	12.82	-.503	19.17	.858	95.64	.383	2.25	.045
FC 903	15.13	1.810	17.89	-.421	95.40	.150	2.45	.246
(632028s1 x FC 601) = 691099	12.93	-.391	17.78	-.530	95.73	.476	2.09	-.102

[1] Values under rt.wt., sucrose %, purity %, and recoverable sugar are adjusted means from the crosses with 2 or more of the common female lines.

[2] This column should always add to zero. Using zero as a central point the best combiners are those having the greatest positive value and rank downward to zero and finally to the negative values.

RELATION OF SUGARBEET QUALITY CHARACTERISTICS AND METHODS OF SAMPLE PREPARATION AND STORAGE

G. W. Maag and R. J. Hecker

One of the principle objectives of a sugarbeet quality study is to establish a simple method or relationship by which sugarbeet quality can be accurately evaluated.

This 1971 experiment was designed to test which of several quantitatively determined nonsucrose components were most significantly related to % sucrose and purity of sugarbeet juices. Since different methods are used for juice preparation and storage, juice extracts were prepared by six methods from each brei sample and analyzed to check the effect of preparation on the measured components.

Materials and Methods. Fifty-five samples, about 20 lbs of sugarbeets each, were harvested from different genotypes and environments to provide diversity among samples. Some samples were selected from different nitrogen (N) treatments, some from commercial genotypes, some from border plantings in test fields, some from Cercospora infected

plants at the Disease Nursery showing varying degrees of leaf spot infection. Six samples were harvested from sugarbeets grown in an area that had been treated with the herbicide Tordon several years ago. These sugarbeets showed considerable residual Tordon effect; they were small and had a very low sucrose content as well as aberrant values for some of the nonsucrose determinations. Analytical data from these samples were not used in some of the statistical studies in this experiment; 49 samples are noted instead of 55 in those cases.

Brei was prepared from each sample of sugarbeets, mixed well and divided. Six juice extracts were prepared as follows:

- Extract 1. Equal parts of brei and boiling glass distilled water were blended for 5 minutes and vacuum filtered. The juice extracts were analyzed immediately.
- Extract 2. Prepared the same as extract 1 except 50 ppm phenylmercuric acetate (PMA) was added to the boiling water.
- Extract 3. Same as extract 1 except extract was quick frozen and stored at -30°F for about 10 days before analysis.
- Extract 4. Same as extract 2, frozen and stored the same as extract 3.
- Extract 5. Brei was quick frozen in a plastic bag and stored at -30°F for about 2 weeks. After thawing, extract was prepared the same as extract 1 and analyzed immediately.
- Extract 6. Extract was prepared the same as extract 5 except with PMA.

Standard sucrose determinations were made on fresh and frozen brei samples. Thin juice purity of each juice extract was determined by standard procedure. Extract polarization and refractometer readings were taken and used to determine extract sucrose, RDS, and purity. In addition, each juice extract was analyzed for conductivity ash, total N, amino N, nitrate (NO_3), chloride (Cl), sodium (Na), and potassium (K), and results were computed to % based on 100 extract sucrose.

Results and Discussion. Sucrose in fresh brei samples ranged from 4.9 to 17.8% (mean of 13.6%), and in frozen brei from 4.8 to 18.3% (mean 13.8%). A t test showed no significant difference in sucrose content due to freezing. The very low sucrose readings were from the samples harvested from the Tordon affected plots mentioned above.

Analyses of variance (AOV) were performed on the data means (55 samples) of each juice extract for all measured components (see table on following page). All comparisons were made to fresh juice (extract 1).

Juice ext.	T.J. % pur.	Extract % Suc.	RDS	% Pur.	% per 100 sucrose Ash	NO_3	Cl	Na	K	Amino N	Total N
1	90.07	7.17	8.48	83.62	4.78	1.44	.18	1.02	1.18	.30	1.34
2	90.08	7.17	8.49	83.57	4.78	1.52	.17	1.03	1.06	.30	1.37
3	91.20**	6.30**	8.37	75.49**	5.30**	1.71**	.19*	1.14**	1.38**	.38**	1.60**
4	91.37**	6.21**	8.27**	75.23**	4.74	1.66**	.18	1.09	1.26	.35**	1.66**
5	90.25	7.19	8.42	84.35	4.82	1.53	.17	1.04	1.04	.31	1.41*
6	89.63	7.17	8.42	84.18	4.62	1.46	.17	1.09	1.28	.30	1.44**
LSD (.01)	.95	.31	.17	3.26	.32	.17	.01	.10	.20	.02	.09
LSD (.05)	.72	.23	.13	2.47	.24	.13	.01	.08	.15	.02	.07

**,* Significantly different from juice extract 1 (1% and 5%, respectively) according to LSD test.

Most components in frozen extracts 3 and 4 showed a significant difference from those in extract 1, with all nonsucrose components higher in quantity in the two frozen extracts. As expected from this, the extract sucrose, RDS, and extract purity were lower, however the thin juice purities for the frozen extracts were higher than extract 1. The refractometer reading means (55 samples) for the thin juice prepared from extract 1 was 22.8; extract 3, 22.88; and extract 4, 22.88. The polarimeter reading means for the same thin juices were 23.35, 24.86, and 24.67, respectively. Since these two readings are used to calculate the thin juice purity, it is apparent that the higher thin juice pol readings of extracts 3 and 4 resulted in their higher thin juice purities. Possibly there was some interaction between changes in the sugars, which may have occurred during the freezing and thawing of the extracts (due to enzymatic action), and during the thin juice preparation, due to the warm basic conditions used at that time. The thin juice prepared from extracts 5 and 6 also showed higher pol readings than thin juice from extracts 1 and 2, but, possibly because freezing the brei caused increased cell rupturing, the refractometer readings were higher also which counterbalanced the higher pol readings in the calculation of the thin juice purity.

A t test, performed on the means (55 samples) from all extracts prepared without PMA compared with those prepared with PMA, showed a significant difference only in conductivity ash and amino N, as shown in the table below.

Juice ext.	T.J. % pur.	Extract % Suc.	RDS	% Pur.	% per 100 sucrose Ash	NO_3	Cl	Na	K	Amino N	Total N
w/o PMA	90.51	6.89	8.42	81.15	4.97	1.56	.18	1.07	1.20	.33	1.45
w/PMA	90.36	6.85	8.39	80.99	4.71*	1.55	.17	1.07	1.20	.32*	1.49

* Significantly different from juice extracts without PMA

Analyses of variance were performed using the means (55 samples) for fresh juice extracts 1 and 2, frozen extracts 3 and 4, and extracts 5 and 6, prepared from frozen brei. An LSD test showed a significant difference between the frozen extract when compared to the fresh extract for all components (Table below). Total N was the only component that showed a significant difference between the extracts prepared from the frozen brei and the fresh extract.

Juice ext.	T.J.	Extract			% per 100 sucrose						
	% pur.	% Suc.	RDS	% Pur.	Ash	NO_3	Cl	Na	K	Amino N	Total N
Fresh ext.	90.08	7.17	8.48	83.60	4.78	1.48	.17	1.02	1.12	.30	1.36
Frozen ext.	91.29*	6.25*	8.32*	75.36*	5.02*	1.68*	.18*	1.12*	1.32*	.37*	1.63*
Ext.from frozen brei	89.94	7.18	8.42	84.27	4.72	1.50	.17	1.06	1.16	.30	1.42*
LSD(.05)	.51	.16	.09	1.75	.17	.09	.01	.05	.11	.01	.05

* Significantly different (5%) from fresh juice extract data means according to Duncan's multiple range test.

A correlation coefficient study, made on all components, showed some correlations to be very high, such as, NO_3 with conductivity ash, Cl with ash, Na with ash, etc. The negative correlation coefficients between thin juice purity and NO_3, Cl, Na, and K were lower for juice extract 5 than for the other juice extracts. Amino N showed very low correlation with other components in all extracts. Extract purity for juice extracts 3 and 4 also showed very low correlations with all components except for extract sucrose and total N.

Correlation coefficients for each component for all juice extracts combined, shown in the accompanying table, reflect some of the high and low correlations mentioned above, especially the amino N and extract purity correlations. The nonsucrose components showed relatively high negative correlations with thin juice purity, extract sucrose, and extract RDS, but lower negative correlations with extract purity. Correlations of the nonsucrose components with one another were usually positive and some were very high.

All juice extracts	T.J. % pur.	%/100 sucrose Ash	NO_3	Cl	Na	K	Amino N	Total N	Extract % Suc.	RDS
%/100 sucrose										
Ash	-.82									
NO_3	-.79	.99								
Cl	-.77	.98	.98							
Na	-.78	.99	.99	.98						
K	-.71	.79	.77	.75	.78					
Amino N	-.27	.02	-.04	-.10	-.06	.22				
Total N	-.75	.73	.69	.65	.68	.74	.64			
Extract										
% sucrose	.73	-.87	-.84	-.83	-.85	-.74	-.26	-.83		
RDS	.79	-.91	-.89	-.88	-.89	-.70	-.07	-.69	.88	
% purity	.37	-.51	-.49	-.47	-.49	-.55	-.39	-.71	.75	.36

To determine which nonsucrose component showed the highest correlation with brei sucrose and thin juice purity, a stepwise regression analysis was performed on the means for 49 samples to fit the model

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + - - - - - - -$$

where Y (the dependent variable) = brei % sucrose or the thin juice purity means, and X_1, X_2, X_3, etc. are the independent variables or nonsucrose components. The stepwise regression program performs the regression by entering one variable at a time into the analysis. At the first step, the independent variable (X_1) having the highest correlation with the dependent variable (Y) is used; X_2 is the independent variable with second highest correlation to Y, holding the independent variable already in the analysis constant. At each step, the coefficient of determination (R^2) is calculated to measure the amount of variation that is accounted for by the model at that point.

When brei sucrose was used as Y, the nonsucrose component found to have the highest correlation with brei sucrose was sodium (X_1). Potassium was found to have second highest correlation to brei sucrose, etc., as shown in the table.

Step number	Independent variable (X) order	Dependent variable (Y)	Coefficient of determination (R^2)
1	Na	% sucrose of	.83110
2	K	Brei	.90545
3	Total N		.91092
4	Cl		.91454
5	NO_3		.91888
6	Ash		.92081
7	Amino N		.92115

When thin juice purity was used in the stepwise regression analysis as the dependent variable Y, the first independent variable entered was conductivity ash (X_1), amino N was second (X_2), NO_3 third (X_3), etc., as shown below.

Step number	Independent variable (X) order	Dependent variable (Y)	Coefficient of determination (R^2)
1	Ash	Thin juice purity	.61737
2	Amino N		.64924
3	NO_3		.66891
4	Total N		.67963
5	K		.68555
6	Cl		.68640
7	Na		.68661

Results of this study indicated freezing juice extracts caused more significant changes in the components measured than when extracts were prepared from frozen brei. All results were compared to fresh juice extracts. Samples were analyzed shortly after preparation or soon after thawing, therefore, the use of a preservative was not a significant factor. A stepwise regression analysis showed sodium, followed by potassium, most highly correlated to brei sucrose, but conductivity ash and amino N were most highly correlated to thin juice purity.

Additional purity studies are underway in our laboratory on 1972 sugarbeet samples. Juice extracts prepared by eight methods are being analyzed. An additional method for sucrose determination is also being incorporated in the 1972 study.

DEVELOPMENT AND EVALUATION OF SUGARBEET BREEDING MATERIAL AND VARIETIES WITH RESISTANCE TO BOTH LEAF SPOT AND CURLY TOP, 1972

G. A. Smith, E. G. Ruppel and Cooperators

Objectives of the LSR-CTR project in 1972 were essentially the same as in the recent past. Field work under leaf spot conditions at Fort Collins in 1972 included an agronomic cooperative test of LSR-CTR varieties; observational tests of numerous sugar company lines; observational tests of Great Western growers joint committee test; observational tests of miscellaneous monogerm type-O lines, experimental hybrids and other material; basic genetic and inheritance study of resistance to leaf spot; and selection of breeding material. Steckling production, reproduction and hybridization were included in the 1972 work program.

The leaf spot epidemic in the Fort Collins leaf spot nursery developed slowly due to unseasonally cool nights after inoculation. Leaf spot readings taken September 4, 1972 on check varieties grown each year indicated that a satisfactory epidemic had developed.

Encouraging results were obtained in 1972 for lines showing high resistance to leaf spot at Fort Collins and to curly top at Logan, Utah. Twenty-six lines tested under greenhouse conditions at Logan had a range of 43.2% to 78.7% of US 41. These same 26 lines had leaf spot readings of 2.0 to 3.0 on our 0-10 leaf spot scale. Twenty-three of the lines pedigrees traced to the cross 632028s1 (F_3) x FC 601. Seed production of these lines was previously evaluated under Oregon conditions and found to be satisfactory. The results for these greenhouse curly top tested lines along with their corresponding field leaf spot readings are presented in Table 1.

Sixty-four entries having several different pollinators were evaluated under field curly top conditions at Logan, Utah. The results for the 15 phentotypically most resistant crosses are presented in Table 2.

Table 1. Early generation lines showing high resistance to curly top and good resistance to leaf spot, Experiment 5A, Fort Collins, 1972. Greenhouse tested at Logan, Utah.

Description	Ft.Collins seed no.	Ft.Collins1/ leaf spot (9/4/72)	Logan,Utah2/ curly top (% of US 41)
⊗ 691099-70A:[F_3,632028s1 x FC 601; mm, T.O.,S.F.]	712003s1c1	3.0	58.7
do.	712006s1c1	2.0	50.0
do.	712027s1c1	3.0	65.2
do.	712094s1c1	2.5	45.7
do.	712096s1c1	3.0	54.4
691099-70A:[F_3,632028s1 x FC 601; mm, T.O.,S.F.] x F_3,(632028s1 x FC 601)CMS	712001H2	2.0	50.0
do.	712003H2	3.0	73.9
do.	712006H2	2.5	47.8
do.	712094H2	3.0	56.5
do.	712096H2	3.0	76.1
⊗ 691099-132B:[F_3,632028s1 x FC 601;mm, T.O.,S.F.]	712024s1c1	3.0	75.7
do.	712054s1	3.0	59.5
do.	712057s1c1	2.5	62.2
do.	712058s1c1	3.0	43.2
do.	712059s1c1	3.0	70.3
do.	712067s1c1	3.0	56.8
do.	712035s1c1	3.0	54.1
do	712061s1c1	2.5	67.6
691099-132B:[F_3,632028s1 x FC 601; mm,T.O.,S.F.] x (F_3, 632028s1 x FC 601)CMS	712023H2	2.5	46.0
do.	712054H2	3.0	48.7
do.	712065H2	2.5	70.3
do.	712069H2	2.0	51.4
do.	712061H2	2.5	68.1
⊗ 642010s1 (622027s1) ♀ x misc: LSR-CTR,mm,T.O. ±,R&r	712034s1	2.5	66.0
67205s1;mm,T.O.±,R.R.;611227-(001); 631000-0;Acc.2643a x 672051s1-CMS(B_1);mm,R	712043H2	3.0	68.1
F_2 fr. crosses between misc. LSR-CTR,mm,T.O.± lines;R&r x Gen. CMS#1,mm,R±	712044H2	3.0	78.7
Acc. 2191 (SP 5481-0)		3.1	
Acc. 2703 (SP 5822-0)		3.0	
US 41			100.0

1/ Leaf spot ratings based on 0-10 scale with 0 = no apparent leaf spot and 10 = complete defoliation.

2/ Curly top percentages in relation to US 41 which is standard check in the C.T. nursery. Values less than 100 indicate more resistance than US 41.

Table 2. Fifteen of the most curly top resistant crosses from a group of 64 field tested, 1972.

Description	F.C.entry no. Rep 1	C.T.(Logan) Grade	C.T.(Logan) % of US 41
[FC(504 x 502/2) x SP 652016sl x SP 662048sl] x McF 413	3	4.0	85.1
(FC 506 x SP 662119sl) x FC 902	5	4.0	85.1
662048sl x FC 901	21	4.0	85.1
FC(603 x 506) x FC 901	23	4.0	85.1
662119sl x FC 902	27	4.0	85.1
FC 603 x FC 903	28	4.0	85.1
SP(681205HOO x 662119sl) x FC 903	29	3.5	74.5
SP(681205HOO x 662119sl) x FC 904	32	3.5	74.5
SP(681205HOO x 662119sl) x 661161H.	36	4.0	85.1
SP(681205HOO x 662119sl) x 681004-0	46	3.5	74.5
SP 642072sl x McF 413	49	3.5	74.5
SP 662048sl x McF 413	50	4.0	85.1
US H9B	52	3.5	74.5
SP 662119sl x McF 413	54	4.0	85.1
SP(681205HOO x 662119sl) x McF 413	55	4.0	85.1

Results of the Cooperative Agronomic Test of LSR-CTR Varieties, 1972.

The varieties described in Table 1 were evaluated by federal, state, and sugar company research personnel in several states in 1972. The entries were tested at Fort Collins under both leaf spot conditions and under disease free conditions. The results of these tests are presented in Tables 2 and 3. Results from the other tests were, in general, poor. These poor tests were for the most part due to bad weather conditions prior to harvest or at harvest. The results are presented from each test separately and the reader may make his own comparisons given the stated conditions. The following discussion will concern only the results of the disease and disease free tests at Fort Collins. In comparing the results from the disease and disease free tests (Tables 2 and 3), it should be recognized that part of the difference is due to location differences. The leaf spot field was located about ¼ mile from the disease free field. The soils were very similar and cultural practices were as near the same as possible. The leaf spot rating under the severe leaf spot conditions at Fort Collins averaged about 3 on the 0-10 scale. Even with this level of resistance, gross sucrose was on the average over 50% less under leaf spot than when grown under leaf spot free conditions. Of course, not all of this reduction in gross sucrose was due to leaf spot. The leaf spot free test was planted 3 weeks earlier than the leaf spot exposed

test. Leaf spot, however, was primarily responsible for an average reduction in sucrose % of 16%. The coefficients of variation (CV) for all characters were greater under leaf spot conditions than under leaf spot free conditions.

Entries 2 and 4 performed best for gross sucrose under leaf spot conditions and entry 2 was the outstanding entry for sucrose % both under leaf spot and leaf spot free conditions.

Entry 3 was tested for gross sucrose under disease free conditions. This superior performance was the result of higher tonnage under both leaf spot and leaf spot free conditions. Entry 2 and 3 have the same female side but the pollinators were FC 703 and McF 413, respectively. (Table 1).

Table 1. Description of material in cooperative evaluation tests of LSR-CTR varieties, 1972.

Entry no.	Seed no.	Variety description	SPG
1	Acc. 2707	US H20 [SL(129 x 133) x SP 6322-0]; furnished by F & M	99
2	SP 711209H09	[FC(504 x 502/2) x SP 652016s1 x SP 662048s1] x FC 703	108
3	SP 711208H09	[FC(504 x 502/2) x SP 652016s1 x SP 662048s1] x McF 413	46
4	SP 711205H017	(FC 506 x SP 662119s1) x FC 904	53
5	SP 711203H017	(FC 506 x SP 662119s1) x FC 902	71
6	SP 711205H03	FC(504 x 502/2) x FC 904	83
7	SP 701203H02	FC 506 x FC 903	133
8	SP 711208H02	FC 506 x McF 413	70
9	SP 711201H03	FC(504 x 502/2) x SP 6322-0; LSR check	122
10	Acc. 2771	US H9B; CTR check from J.S. McFarlane	107
11		Local check to be furnished by cooperator	

Numbers 1 through 8 are monogerm and have some resistance to both leaf spot and curly top. Number 2 should have some resistance to Rhizoctonia because of the Rhizoctonia resistance of the male parent, FC 703. All hybridization was enforced by means of male sterility.

Table 2. Cooperative Agronomic Test of LSR-CTR Varieties, 1972
Location: Ft. Collins, Colo. (3A), under severe leaf spot

Seed no. or variety	Entry no.	Acre yield: Gross sucrose		Acre yield: Beets		Sucrose		Leaf spot 1/	Purity
		Lbs.	% check	Tons	% check	%	% check		%
Acc. 2707	1	3639	100	14.04	100	12.96	100	3.6	91.70
SP 711209H09	2	4394	121	14.11	101	15.58	120	3.2	93.93
SP 711208H09	3	4226	116	15.15	108	13.94	108	3.3	92.32
SP 711205H017	4	4414	121	15.38	110	14.35	111	3.1	92.85
SP 711203H017	5	4003	110	14.83	106	13.47	104	3.1	93.31
SP 711205H03	6	4225	116	14.05	100	15.04	116	3.1	93.23
SP 701203H02	7	3406	94	12.40	88	13.73	106	2.9	93.36
SP 711208H02	8	3905	107	13.98	100	13.94	108	2.9	92.56
SP 711201H03	9	3605	99	12.42	88	14.44	111	3.1	93.38
Acc. 2771	10	3305	91	13.72	98	12.02	93	5.6	90.70
A71-5 (check)	11	4471	123	14.83	106	15.07	116	3.6	92.28
General mean		3963		14.08		14.05		3.4	92.69
CV (%)		11.26		9.49		3.70		10.63	1.07
LSD (.05)		540	15	1.55	11	0.60	5	0.42	1.15

1/ Basis of leaf spot grades: 0-10 scale; 0 = no infection, 10 = defoliation.

Conducted by: G. A. Smith and E. G. Ruppel.

Dates of Planting and Harvest: May 4 and September 25, 1972.

Experimental Design (Including No. of Reps): Randomized complete block with 6 replications of 2 row plots. Plot length, 20 feet.

Determination of Beet Yield and Sucrose Percentage: Standard Methods.

Leaf Spot Exposure: Severe; artificially induced.

Curly Top Exposure: None.

Other Diseases and Pests: None.

Reliability of Test and Remarks: Very satisfactory.

Table 3. Cooperative Agronomic Test of LSR-CTR Varieties, 1972
Location: Ft. Collins, Colo. (Exp. 5) disease free.

Seed no. or variety	Entry no.	Acre yield: Gross sucrose		Acre yield: Beets		Sucrose		Purity
		Lbs.	% check	Tons	% check	%	% check	%
Acc. 2707	1	6951	100	21.24	100	16.29	100	95.12
SP 711209H09	2	7386	106	21.08	99	17.52	108	96.40
SP 711208H09	3	8102	117	24.58	116	16.45	101	95.35
SP 711205H017	4	7576	109	22.23	105	17.03	105	95.93
SP 711203H017	5	7664	110	23.18	109	16.53	101	95.35
SP 711205H03	6	7041	101	20.92	98	16.84	103	95.97
SP 701203H02	7	7505	108	22.57	106	16.62	102	96.03
SP 711208H02	8	7460	107	22.55	106	16.53	101	95.93
SP 711201H03	9	6281	90	19.15	90	16.38	101	95.32
Acc. 2771	10	7751	112	23.63	111	16.38	101	95.68
A71-5 (check)	11	8187	118	23.66	111	17.28	106	96.53
General mean		7446		22.25		16.71		95.78
CV (%)		7.31		5.50		3.18		1.31
LSD (.05)		631	9	1.42	7	0.62	4	1.46

Conducted by: G. A. Smith.

Dates of Planting and Harvest: April 11; October 3.

Experimental Design (Including No. of Reps): Randomized complete block with 6 replications of 2 row plots. Plot length 20 feet.

Determination of Beet Yield and Sucrose Percentage: Standard methods.

Leaf Spot Exposure: Negligible.

Curly Top Exposure: None.

Other Diseases and Pests: None.

Reliability of Test and Remarks: Very satisfactory.

Table 4. Cooperative Agronomic Test of LSR-CTR Varieties, 1972
Location: Longmont, Colorado

Seed no. or variety	Entry no.	Acre yield: Gross sucrose		Acre yield: Beets		Sucrose		Plants per 100'
		Lbs.	% check	Tons	% check	%	% check	No.
Acc. 2707	1	3258.7	100	14.6	100	11.2	100	99.4
SP 711209H09	2	3699.1	114	14.7	101	12.8	114	89.3
SP 711208H09*	3	4767.1	146	21.4	147	11.2	100	69.1
SP 711205H017	4	3488.3	107	15.5	106	11.2	100	76.7
SP 711203H017	5	3035.6	93	14.7	101	10.3	92	75.2
SP 711205H03	6	3165.1	97	13.3	91	11.9	106	84.9
SP 701203H02	7	2947.1	90	13.2	90	11.1	99	87.2
SP 711208H02	8	3360.0	103	14.5	99	11.6	104	79.3
SP 711201H03	9	2735.1	84	11.6	80	11.6	104	82.1
Acc. 2771	10	3661.7	112	16.2	111	11.1	99	89.5
Company check	11	4257.8	131	16.2	111	13.2	118	102.7
General mean		3567.9		15.3		11.7		85.7
CV (%)		15.8		15.3		6.3		
LSD (.05)		748.1	23	3.2	22	1.0	9	

* Only 35.4% of potential row length was harvestable.

Conducted by: Great Western Sugar Company.

Dates of Planting and Harvest: Planted 4/10/72; Harvested 9/15/72.

Experimental Design (Including No. of Reps): 3 x 4 Rectangular Lattice (Triple) - 4 Row Plots - 6 Replications.

Determination of Beet Yield and Sucrose Percentage: All beets were harvested in competitive stand area. 20 ft. per row, where possible. Considerable trimming was required in most plots.

Leaf Spot Exposure: None.

Curly Top Exposure: None.

Other Diseases and Pests: Field was fumigated for nematodes and treated for sugarbeet root maggot.

Reliability of Test and Remarks: Poor Test - The plants were exposed to a spring frost where stand losses occurred. In most plots final stands were uneven and long gaps occurred. Considerable trimming was required to eliminate skips and non competitive beets.

Table 5. Cooperative Agronomic Test of LSR-CTR Varieties, 1972
Location: Hereford, Texas

Seed no. or variety	Entry no.	Acre yield: Gross sucrose		Acre yield: Beets		Sucrose		Plants per 100'	Leaf spot	Curly Top Grade
		Lbs.	% check	Tons	% check	%	% check	No.		
Acc. 2707	1	6318	100	27.2	100	11.59	100	167	3.5	4.5
SP 711209H09	2	6062	96	23.7	87	12.78	110	169	2.8	4.0
SP 711208H09	3	7219	114	30.6	113	11.86	102	156	2.8	2.8
SP 711205H017	4	6158	98	24.3	89	12.66	109	158	2.5	4.0
SP 711203H017	5	6436	102	26.5	97	12.13	105	165	2.8	3.0
SP 711205H03	6	6152	97	24.4	90	12.54	108	152	2.8	3.5
SP 701203H02	7	5275	84	21.3	78	12.48	108	174	2.8	3.3
SP 711208H02	8	6317	100	26.8	99	11.80	102	156	2.0	4.0
SP 711201H03	9	6191	98	25.3	93	12.18	105	159	2.0	5.0
Acc. 2771	10	6150	97	26.5	97	11.67	101	156	4.3	2.5
Local Ck. 1	11	7090	112	28.9	106	12.30	106	163	3.5	3.5
Local Ck. 2	12	6649	105	27.9	103	11.91	103	172	4.5	4.3
Local Ck. 3	13	5480	87	23.4	86	11.81	102	155	4.3	3.3
General mean		6269		25.9		12.13		162	3.1	3.7
CV (%)		23		22.0		5.96				
LSD (.05)		NS		NS		.68	6			

Conducted by: Holly Sugar Corporation.

Dates of Planting and Harvest: Planted 3/24/72; Harvest started 11/16/72, Harvest completed 12/24/72.

Experimental Design(Including No.of Reps): Randomized complete block, 9 replications.

Determination of Beet Yield and Sucrose Percentage: Standard methods.

Leaf Spot Exposure: Data presented from leafspot nursery. Good disease exposure.

Curly Top Exposure: Data from curly top nursery. Poor uniformity of disease.

Other Diseases and Pests: None.

Reliability of Test and Remarks: The test would be rated poor due to early herbicide damage and especially to the difficult harvest period. Freezing wet weather conditions severly hampered harvest.

Table 6. Cooperative Agronomic Test of LSR-CTR Varieties, 1972
Location: Farmington, New Mexico

Seed no. or variety	Entry no.	Acre yield: Gross sucrose		Acre yield: Beets		Sucrose		Plants per 100'
		Lbs.	% check	Tons	% check	%	% check	No.
Acc. 2707	1	9517	100	32.65	100	14.70	100	109
SP 711209H09	2	11154	117	33.61	103	16.77	114	120
SP 711208H09	3	8488	89	29.99	92	14.03	95	117
SP 711205H017	4	8765	92	29.17	89	14.40	98	115
SP 711203H017	5	9042	95	31.57	97	13.97	95	97
SP 711205H03	6	11444	120	36.18	111	15.67	107	129
SP 701203H02	7	9425	99	31.10	95	15.13	103	107
SP 711208H02	8	9926	104	31.17	95	15.70	107	120
SP 711201H03	9	9174	96	31.26	96	14.67	100	132
Acc. 2771	10	9860	104	34.01	104	14.67	100	110
American No. 4	11	9676	102	27.55	84	17.53	119	114
General mean		9676		31.66		15.2		115
CV (%)		20.9		15.3				12.5
LSD (.05)		ns		ns				ns

Conducted by: E. J. Gregory.

Dates of Planting and Harvest: Planted 4/18/72; Harvested 11/28/72.

Experimental Design (Including No. of Reps): Randomized complete block with 3 replications.

Determination of Beet Yield and Sucrose Percentage: Harvested 10 feet of two 20-inch rows out of the center of each 20-foot two row plots. A random sample weighing about 30 pounds was taken from each plot for sucrose determinations.

Leaf Spot Exposure: None.

Curly Top Exposure: None - only one or two plants in the entire trial.

Other Diseases and Pests: Bacterial or common storage rot organisms were isolated from roots before sucrose analysis. Crown damage was evident from freezing in field.

Reliability of Test and Remarks: Fair - trial area was quite variable and the number of replications too few.

Table 7. Cooperative Agronomic Test of LSR-CTR Varieties, 1972
Location: Farmington, New Mexico

Seed no. or variety	Entry no.	Acre yield: Gross sucrose Lbs.	Acre yield: Gross sucrose % check	Acre yield: Beets Tons	Acre yield: Beets % check	Sucrose %	Sucrose % check	Plants per 100' No.
Acc. 2707	1	8439	100	28.9	100	14.4	100	100
SP 711209H09	2	10947	130	31.5	109	17.4	121	129
SP 711208H09	3	8412	100	27.9	97	15.0	104	120
SP 711205H017	4	9834	117	32.7	113	15.1	105	124
SP 711203H017	5	12404	147	36.4	126	16.9	117	132
SP 711205H03	6	9904	117	30.2	105	16.3	113	120
SP 701203H02	7	11198	133	36.0	125	15.5	108	115
SP 711208H02	8	11369	135	34.4	119	16.6	115	122
SP 711201H03	9	8954	106	29.3	101	15.1	105	120
Acc. 2771	10	10670	126	35.4	122	15.0	104	130
American No. 4	11	10032	119	27.1	94	18.5	128	154
General mean		10197		28.8		16.0		124
CV (%)		14.1		17.7				13.7
LSD (.05)		2442	29	5.9	20			ns

Conducted by: E. J. Gregory.

Dates of Planting and Harvest: Planting - April 18; Harvest - October 10

Experimental Design (Including No. of Reps): Randomized complete block, 3 replications.

Determination of Beet Yield and Sucrose Percentage: Harvested 10 feet of two 20-inch rows out of the center of each 20 foot two row plots. A random sample weighing approximately 30 pounds was taken from each plot for sucrose determination.

Leaf Spot Exposure: None.

Curly Top Exposure: None - one or two plants in the entire trial.

Other Diseases and Pests: None.

Reliability of Test and Remarks: Plot area was quite variable and number of replications were too few. A wet cold fall made harvest difficult.

Table 8. Cooperative Agronomic Test of LSR-CTR Varieties, 1972
Location: Bonanza Lease - Willcox, Arizona

Seed no. or variety	Entry no.	Acre yield: Gross sucrose Lbs.	Acre yield: Gross sucrose % check	Acre yield: Beets Tons	Acre yield: Beets % check	Sucrose %	Sucrose % check	Curly Top
Acc. 2707	1	9235	100	37.5	100	12.4	100	1.4
SP 711209H09	2	9898	107	37.2	99	13.3	107	1.9
SP 711208H09	3	7194	78	28.1	75	12.8	103	1.6
SP 711205H017	4	7001	76	27.8	74	12.6	102	1.1
SP 711203H017	5	9387	102	35.3	94	13.3	107	1.4
SP 711205H03	6	7112	77	27.8	74	12.8	103	2.0
SP 701203H02	7	8010	87	33.1	88	12.1	98	1.8
SP 711208H02	8	8725	94	34.4	92	12.7	102	2.0
SP 711201H03	9	9158	99	36.3	97	12.6	102	3.3
Acc. 2771	10	9176	99	42.5	113	10.8	87	1.3
S-701H1	11	9220	100	39.7	106	11.6	94	1.3
Spreckels(US H9)	12	9638	104	41.2	110	11.7	94	1.6
General mean		8646		35.1		12.4		1.7
CV (%)		6.60		5.3		3.5		
LSD(.05)		1656	18	5.3	14	1.2	10	

Conducted by: Spreckels Sugar Division of Amstar Corp.

Dates Of Planting and Harvest: April 5, 1972; November 28, 1972.

Experimental Design(Including No.of Reps): Split-plot with varieties as whole plots and Thimet and no Thimet as sub-plots. 8 reps planted, but only 4 harvested. Sub-plot size: 1 row x 65 ft.; rows 30" apart. Thimet data not presented.

Determination of Beet Yield and Sucrose Percentage: Beet yields from sub-plot weights. Two random sugar samples of 20-25 lbs. each per sub-plot.

Leaf Spot Exposure: Negligible.

Curly Top Exposure: Mild; a moderately late infection.

Other Diseases and Pests: None.

Reliability of Test and Remarks: Due to interruption of harvest by rain only 4 reps were considered valid for analyses. Consequently, experimental errors were high and reliability of test is only fair to good. Stands were excellent. 124 lbs. of nitrogen applied by 200 lbs. of 16-20-0 pre-plant and 200 lbs. of Urea sidedressed. One pound a.i. of Thimet pre-planted 5" under seed row for control of curly top on one-half of each whole plot per replication. Use of Thimet increased gross sucrose an average of 7%; curly top readings were reduced an average of 29%. Data analyzed as a RCB design with 24 treatments and 4 reps. Basis of CT grade is given in the following table:

		Severity of Symptoms: Severe	Moderate	Mild
% of Plants Infected	High	5	4	3
	Medium	4	3	2
	Low	3	2	1

Table 9. Cooperative Agronomic Test of LSR-CTR Varieties, 1972
Location: Ulysses, Kansas.

Seed no. or variety	Entry no.	Acre yield: Gross sucrose	Acre yield: Beets	Sucrose	Impurity index	Recov. sugar/ acre	
		Lbs.	Tons	%			% check
Acc. 2707	1	5907	27.0	10.94	1423	4643	100
SP 711209H09	2	5421	22.3	12.19	1262	4397	95
SP 711208H09	3	5171	23.2	11.14	1446	4063	88
SP 711205H017	4	6343	29.3	10.78	1452	4967	107
SP 711203H017	5	6645	30.5	10.88	1403	5252	113
SP 711205H03	6	6812	29.0	11.78	1422	5364	116
SP 701203H02	7	5945	26.1	11.36	1257	4836	104
SP 711208H02	8	6570	28.9	11.38	1380	5202	112
SP 711201H03	9	6912	29.3	11.77	1310	5578	120
Acc. 2771	10	5218	25.9	10.06	1538	4010	86
FC506 X FC901	11	6519	26.8	12.18	1239	5314	114
General mean		6144.5	27.3	11.27	1374	4885	
CV (%)		9.8	7.2	6.33	10	11	
LSD (.05)		701.8	2.3	0.83	164	622	13

Conducted by: American Crystal Sugar Company Research Personnel.

Dates of Planting and Harvest: April 17; October 12.

Experimental Design (Including No. of Reps): Equalized random block; 6 replications.

Determination of Beet Yield and Sucrose Percentage: Standard procedure.

Leaf Spot Exposure: Mild.

Curly Top Exposure: None.

Other Diseases and Pests: Negligible.

Reliability of Test and Remarks: Very satisfactory. Above average rainfall throughout season and early harvest account for low sucrose percentage.

Table 10. Cooperative Agronomic Test of LSR-CTR Varieties, 1972
Location: East Grand Forks, Minnesota

Seed no. or variety	Entry no.	Acre yield: Gross sucrose	Acre yield: Beets	Sucrose	Impurity index	Recov. sugar/ acre	
		Lbs.	Tons	%			% check
Acc. 2707	1	5927	19.2	15.45	668	5333	100
SP 711209H09	2	4901	15.6	15.75	595	4462	84
SP 711208H09	3	5001	16.7	14.96	696	4480	84
SP 711205H017	4	5389	16.9	15.93	579	4921	92
SP 711203H017	5	5612	18.1	15.51	621	5090	95
SP 711205H03	6	5545	17.2	16.18	535	5100	96
SP 701203H02	7	5847	18.5	15.79	683	5249	98
SP 711208H02	8	5743	18.2	15.76	666	5168	97
SP 711201H03	9	5109	16.3	15.67	636	4622	87
Acc. 2771	10	5998	16.2	15.41	681	5386	101
FC506 x FC901	11	5458	16.9	16.19	574	4986	93
General mean		5509	17.4	15.64	635.3	4984	
CV (%)		4.8	14.2	2.36	6.8	4.7	
LSD (.05)		305	2.9	0.43	50.3	272.7	5

Conducted by: American Crystal Sugar Company Research Personnel.

Dates of Planting and Harvest: May 16; October 11.

Experimental Design (Including No. of Reps): Equalized random block; 6 replications.

Determination of Beet Yield and Sucrose Percentage: Standard procedure.

Leaf Spot Exposure: None.

Curly Top Exposure: None.

Other Diseases and Pests: Negligible.

Reliability of Test and Remarks: Very Satisfactory.

SUGARBEET RESEARCH

1972 Report

Section E

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American Crystal Sugar Company
Holly Sugar Corporation
Buckeye Sugars, Inc.
Michigan Sugar Company
Monitor Sugar Division
Northern Ohio Sugar Company
Michigan Agricultural Experiment Station
Minnesota Agricultural Experiment Station
North Dakota Agricultural Experiment Station
Red River Valley Sugarbeet Growers Association, Inc.

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CONTENTS

EVALUATION OF SUGARBEET HYBRIDS

Prepared by G. J. Hogaboam and R. C. Zielke

The evaluation program in 1972 was again cooperative with the Farmers and Manufacturers Beet Sugar Association and its member companies. Additional tests in Ohio were conducted by the Northern Ohio Sugar Company. Hybrids were also furnished the Holly Sugar Corporation for evaluation. Betaseed conducted the tests for Holly at Saginaw, Michigan and Stanton, Minnesota. The results of these tests were reported by Holly Sugar Corporation and are included in this report.

Some of the characters (items) for which we analyzed data, such as recoverable white sugar per acre, and recoverable white sugar per ton, were calculated with formulas derived by M. G. Frakes, Director of Research, Michigan Sugar Company. The methods and techniques for such are outlined on page E2, 1970 Sugarbeet Research Report.

In the 6x6 Latin Square Tests, and the Area Evaluation Tests, all individual experimental data were analyzed in indicated units and then the performance and LSD values were calculated as percent of the general mean. The analysis by area had the "location" effects removed by compositing the data as percent of the general mean. Composite tests were made for the tests in the Ohio area, for tests in Michigan, and then all tests combined. The two Area Evaluation Tests are reported separately and combined for the two Michigan locations. Stand problems in the Ohio Area Evaluation Test made it unsuitable for harvest and analysis.

One commercial hybrid for the 1972 6x6 Latin Square is entry number 1, UI(11863x12161)xSP6322-0. This variety is very similar in breeding background to SL(129x133)xSP6322-0 which is US H20. The other commercial entry is number 2, UI(100363x2161)xSP6322-0. Entry 3, SP69550-01x SP6322-0, is a high quality line which has been in the Latin Square Tests since 1970. Entry 4, UI(100363x2161)xSP6528-01 has a testing history similar to entry 3. Entries 5 and 6 are in the Latin Square Tests for the first time this year.

1972 6x6 Latin Square Tests

The quality (Recoverable white sugar per ton) of entries 3 and 6 across all tests was outstanding. The yields of these two entries were disappointing, especially entry 6. The yield performance, in Michigan, of entries 1 and 2 was outstanding such that they also gave the most sugar per acre with one exception. In Ohio, both black root and leaf spot had an influence on test results.

Combined analysis

Since there were 4 varieties which had been included for the past 3 years, a combined analysis of these results were made. Two types of combinations were calculated. One used averages by area, by years, for varieties. This made possible examination of variety by area and variety by year interactions. The other type analysis was used when significant interactions did not exist. It involved ignoring years and (in most cases) areas to treat each experiment as a trial. The results were as follows:

Recoverable white sugar per acre - There were no significant interactions or differences between varieties.

Tons per acre of roots - Neither of the interactions were significant. Entry 3 was significantly lower in yield (8% less than US H20) than the other 3 varieties. There were no significant differences among the other 3 varieties.

Recoverable white sugar per ton - There was a significant variety by area interaction (caused by a greater difference between entry 2 and 3 in Ohio than in Michigan). The variety by year interaction was not significant. Entry 3 was significantly higher than all other varieties (7% better in Michigan and 9% better in Ohio than US H20). Also, entry 4 was significantly better than entries 1 and 2.

Percent sucrose - No significant interactions. Entry 3 was significantly better than all others (6% better than US H20). Entry 4 was significantly better than entries 1 and 2.

Percent clear juice purity - The variety by year interaction was not significant but the variety by area was. In the Ohio area, entry 3 was higher than all other entries while in Michigan it was not significantly better than entry 4. Both entries 3 and 4 were better than entries 1 and 2 in both areas. Entry 3 was 1.16% better in Ohio and 0.58% better in Michigan than US H20.

Area Evaluation Tests

The Area Evaluation Tests contained three of the same varieties as the 6x6 Latin Squares. Entry 1 in the Latin Squares was entry 32 in the Area Evaluation. Entry 2 corresponded to entry 33 and entry 3 corresponded to entry 10. Also, entries 11 and 12 were very similar to entries 32 and 33, respectively, since they differed only in the degree of seed development in the F_1 phase (entry 11 and entry 32) or in the pollinator phase (SP6822-0(P) was a subsequent increase of SP6322-0).

Entries 11, 12, 32 and 33 did not differ significantly for any characters analyzed as averages for the two locations. Entry 10 was lower than these 4 varieties in tons per acre, significantly equal (but lower) in recoverable white sugar per acre (RWSA), better in sugar per ton (RWST) and percent sucrose, equal for % purity, but much lower in stand

of beets.

One hybrid (entry 13) exceeded the general mean for all characters at all locations. Its' overall performance was similar to entries 32 and 33 but tended to be higher in RWST, % sucrose, and %CJP.

Only entries 22 and 23 significantly exceeded the General Mean for tons per acre over both locations, but six others were more than 6% above the mean. Entries 3, 4, 7, and 10, all of which involve SP69550-0(1) in the F_1 phase, exceeded the mean of two locations for sugar per ton and % sucrose. Only entry 7 exceeded the mean for % CJP.

1972, 6x6 LSQ tests, Data as % of Performance
of General Mean (G.M.)

Item	Location Code**	Variety Code@ 1	2	3	4	5	6	LSD 5 % on % G.M.	Actual G.M.	C.V.%
Re-coverable white sugar per acre	3	99.2	100.3	108.5	96.0	95.0	100.8	NS	6595 lbs	7.90
	4	97.5	94.3	99.1	89.6	110.1	109.5	13.7	5172 lbs	11.39
	Ohio Avg	98.4	97.3	103.8	92.8	102.6	105.2	NS	100 %	6.88
	5*	105.3	105.4	98.4	106.4	91.3	93.3	7.6	8767 lbs	4.17
	6	104.5	105.0	98.7	101.3	96.5	93.9	NS	5767 lbs	8.15
	7	109.1	103.7	103.0	102.7	93.0	88.6	9.2	5900 lbs	7.65
	Mich Avg	106.3	104.7	100.0	103.5	93.6	91.9	4.9	100 %	2.68
	Grand Avg	103.1	101.7	101.5	99.2	97.2	97.2	NS	100 %	6.75
Roots-Tons/ Acre	3	101.4	105.6	102.9	100.1	95.6	94.4	7.3	30.8 tons	6.04
	4	103.0	102.4	93.8	94.4	106.7	99.7	NS	24.2 tons	10.42
	Ohio Avg	102.2	104.0	98.4	97.2	101.1	97.0	NS	100 %	5.27
	5*	108.9	109.2	94.6	106.3	92.6	88.3	6.9	31.9 tons	3.79
	6	107.7	108.7	94.4	103.7	96.8	88.6	7.5	23.6 tons	6.19
	7	111.5	109.2	95.1	105.5	94.2	84.5	7.4	24.3 tons	6.17
	Mich Avg	109.4	109.0	94.7	105.2	94.5	87.1	3.2	100 %	1.76
	Grand Avg	106.5	107.0	96.2	102.0	97.2	91.1	6.8	100 %	5.12
Re-coverable white sugar per ton of roots	3	97.8	94.7	105.6	96.1	98.7	107.1	6.0	214.2 lbs	4.95
	4	94.8	91.8	105.1	94.6	103.5	110.1	6.2	213.3 lbs	5.11
	Ohio Avg	96.3	93.3	105.3	95.3	101.1	108.6	5.8	100 %	2.27
	5*	96.5	96.3	103.7	99.8	98.4	105.4	6.0	275.3 lbs	3.28
	6	96.8	96.2	104.4	97.2	99.6	105.8	4.5	245.0 lbs	3.70
	7	97.6	94.6	107.9	97.1	98.5	104.3	6.7	243.4 lbs	5.52
	Mich Avg	96.9	95.7	105.3	98.0	98.8	105.2	2.5	100 %	1.39
	Grand Avg	96.7	94.7	105.3	97.0	99.7	106.5	2.7	100 %	2.03

*, **, @, see page E7.

1972, 6x6 LSQ tests, Data as % of Performance of General Mean (G.M.)

Item	Location Code**	Variety Code@ 1	2	3	4	5	6	LSD 5 % on % G.M.	Actual G.M.	C.V.%
% Sucrose	3	98.3	96.2	104.2	96.6	99.0	105.7	4.1	13.47	3.44
	4	96.1	93.1	103.8	96.0	102.8	108.1	5.1	12.94	4.23
	Ohio Avg	97.2	94.7	104.0	96.3	100.9	106.9	4.8	100(%)	1.88
	5*	97.5	97.0	103.4	99.3	99.0	103.7	4.1	16.52	2.24
	6	96.9	96.9	104.3	97.7	99.8	104.4	3.7	14.64	3.07
	7	98.3	96.0	106.1	97.5	98.7	103.4	5.5	14.75	4.55
	Mich Avg	97.6	96.6	104.6	98.2	99.2	103.8	1.7	100(%)	0.92
	Grand Avg	97.4	95.8	104.4	97.4	99.9	105.1	2.1	100(%)	1.59
% CJ purity	3	99.8	99.3	100.6	99.8	99.9	100.6	NS	91.93	0.84
	4	99.4	99.5	100.6	99.4	100.3	100.8	0.9	93.83	0.70
	Ohio Avg	99.6	99.4	100.6	99.6	100.1	100.7	0.7	100(%)	0.26
	5*	99.5	99.7	100.1	100.3	99.7	100.8	NS	93.77	0.70
	6	100.0	99.7	99.9	99.8	99.9	100.6	NS	94.30	0.60
	7	99.7	99.4	100.7	99.9	100.0	100.3	NS	93.52	0.87
	Mich Avg	99.7	99.6	100.2	100.0	99.8	100.6	0.5	100(%)	0.29
	Grand Avg	99.7	99.5	100.4	99.8	99.9	100.6	0.4	100(%)	0.29
Beets per 100' of row	3	110.8	103.8	104.8	94.6	91.7	94.3	8.8	76.4 beets	7.32
	4	114.5	107.6	88.7	90.0	95.5	103.7	9.3	83.5 beets	7.69
	Ohio Avg	112.7	105.7	96.7	92.3	93.6	99.0	NS	100(%)	6.42
	5*	104.6	106.4	98.1	114.9	88.7	87.3	15.1	101.3 beets	8.31
	6	114.9	111.5	96.6	102.3	89.4	85.3	8.6	78.7 beets	7.18
	7	116.6	115.6	106.1	95.0	87.8	78.8	7.8	80.2 beets	6.46
	Mich Avg	112.0	111.2	100.3	104.1	88.6	83.8	11.8	100(%)	6.50
	Grand Avg	112.3	109.0	98.9	99.4	90.6	89.8	10.0	100(%)	7.59

*, **, @, see page E7.

Footnotes and notes concerning the 1972 6x6 Latin Square Tests

@ Variety Code

Entry No.	Seed No.		
1	UI(1861	x 2161)	x SP6322-0
2	UI(100363	x 2161)	x SP6322-0
3	SP69550-01		x SP6322-0
4	UI(100363	x 2161)	x SP6528-01
5	SP(6426-01	x 67550-0)	x SP6822-0
6	SP(69557-01	x 69550-0)	x SP6922-0

** Location Code

3 - James Schroeder, Ottawa, Ohio

4 - Ray Cunningham, Old Fort, Ohio

5 - Walter Frahm, Frankenmuth, Michigan

6 - Dale Smith, Alma, Michigan

7 - Saginaw Valley Bean-Beet Research Farm, Saginaw, Michigan

* Only 3 replications were harvested at the Frahm farm, hence it was analyzed as a randomized complete block.

The 6x6 Latin Square Tests are based on data from 4-row plots 30 feet long except for 33 foot plots for Experiment 7. The data from each test were analyzed on an actual basis then converted to percent of the General Mean for summary purposes. Summary data is calculated from the percentage performance data. This technique gives each test an equal value in a combined analysis. Thus test (location) effects are zero, but the values of the interactions involving tests are still present and valid. This is especially helpful when years are involved since the effect of years per.se. are removed, but not the interactions involving years.

Analysis of four varieties tested over three years in two areas. Data from 17 tests.

				PERFORMANCE AS PERCENT MEAN OF THE FOUR HYBRIDS						
				RWS/A	Tons/A	Rec. W. Sugar/T		% Sucrose	% C. J. Purity	
CMS	"0"	Pollen	Area→	Both	Both	Ohio	Mich.	Both	Ohio	Mich.
UI1861	UI2161	SP6322-0		99.04	101.47a	97.50c	97.46c	98.08c	99.64c	99.78b
UI100363	UI2161	SP6322-0		100.45	103.59a	95.74c	97.84c	97.71c	99.50c	99.70b
SP69550-01		SP6322-0		98.67	93.25b	106.75a	104.62a	104.31a	100.80a	100.36a
UI100363	UI2161	SP6528-01		101.84	101.68a	100.01b	100.08b	99.89b	100.06b	100.16a
		LSD 5%		NS	2.28	2.41	2.00	1.27	0.36	0.32

INTERACTION	F VALUE OF INTERACTION				
Variety x years	NS	NS	NS	NS	NS
Variety x "Area"	NS	NS	6.22*	NS	10.34*

a, b, c Values in the same column with the same letter following them are not significantly different from one another.

AREA EVALUATION TESTS@ - 1972

ENTRY No.	HYBRID CMS	"0"	Pollen	# Rec. White Su./A. Loc.1	Loc.2	Mean	Tons Roots per Acre Loc.1	Loc.2	Mean
				PERFORMANCE IN PERCENT OF THE TEST MEAN					
1	SP6842-01	SP69550-0	SP6922-0	97.7	95.7	96.7	96.3	93.3	94.8
2	SP67553-1pk.		SP6322-0	88.0-	84.3-	86.2-	87.6-	82.7-	85.1-
3	SP69523-01	SP69550-0	SP6922-0	99.9	91.7	95.8	91.4-	89.5	90.4
4	SP69542-01	SP69550-0	SP6922-0	96.8	83.5-	90.2	92.9	78.4-	85.7-
5	SP67550-01	SP68745.A	SP6922-0	97.0	100.3	98.7	97.0	100.1	98.6
6	SP68641-1		SP6822-0(B)	93.0	97.9	95.5	95.1	103.5	99.3
7	SP69550-01		SP6934-0	97.4	95.7	96.6	89.5-	86.9-	88.2-
8	SP67550-01		SP6822-0(NB)*	96.5	103.6	100.0	93.6	100.9	97.3
9	UI100363	SP6423-0	SP6822-0(P)	101.6	110.4	106.0	104.6	109.4	107.0
10	SP69550-01		SP6322-0	100.8	97.6	99.2	95.5	92.9	94.2
11	UI11866	UI12166	SP6822-0(P)	106.9	108.2	107.6	107.3	110.7	109.0
12	UI100363	UI12163	SP6822-0(P)	100.7	113.3+	107.0	102.7	111.9+	107.3
13	UI100363	UI12163	70P21	109.2+	109.2	109.2	107.3	105.1	106.2
14	UI100363	UI12163	70P23	103.1	100.0	101.6	106.5	99.6	103.1
15	UI11866	UI12166	70P21	106.4	102.6	104.5	103.9	103.9	103.9
16	UI11866	UI12166	70P23	103.6	92.4	98.0	101.6	87.8-	94.7
17	UI12166		SP6322-0	98.4	97.1	97.8	97.4	101.3	99.4
18	UI12166		SP6822-0(P)	101.7	99.0	100.3	102.7	98.8	100.8
19	UI102167		SP6322-0	99.8	95.8	97.8	100.1	93.7	96.9
20	UI102167E		SP6822-0(P)	102.2	108.8	105.5	102.0	109.4	105.7
21	UI104367		SP6322-0	99.0	98.2	98.6	102.7	102.6	102.7
22	UI104366B		SP6822-0(P)	107.9	108.6	108.3	108.4+	112.8+	110.6+
23	UI100363		SP6822-0(P)	102.1	115.4+	108.7	105.0	117.4+	111 2+
24	FC506		SP6822-0(P)	87.5-	94.3	90.9	87.6-	92.8	90.2-
25	SP7042-01		SP6822-0(P)	102.4	93.1	97.7	103.5	100.5	102.0
26	EL36c2		SP6822-0(P)	97.5	96.0	96.8	104.2	105.1	104.7
27	(69B5x02)		SP6822-0(P)	95.2	101.4	98.3	96.7	100.5	98.6
28	SP69550-01	UI2161	SP6822-0(P)	99.5	103.4	101.5	97.4	100.5	99.0
29	SP6926-01	UI2161	SP6822-0(P)	108.1	101.3	104.7	108.8+	100.9	104.9
30	SP69550-01	EL36	SP6822-0(P)	96.8	100.7	98.7	96.3	103.5	99.9
31	SP6926-01	EL36	SP6822-0(P)	97.3	100.6	99.0	104.2	109.4	106.8
32	UI1861	UI2161	SP6322-0	104.6	100.2	102.4	102.7	99.2	101.0
33	UI100363	UI2161	SP6322-0	102.7	115.9+	109.3	104.6	112.4+	108.5
34	SP6926-0		70P21	99.7	87.4-	93.6	100.1	87.3-	93.7
35	SP6926-0		70P23	97.6	88.7	93.2	99.3	90.3	94.8
36	UI100363	SP6721-0	SP6822-0(P)	101.2	107.6	104.4	103.1	105.1	104.1
	LSD 5% (for above data units)			8.5	12.2	10.1	8.1	10.9	9.6
	General Mean (actual)			7326#	5580#	100%	26.4T	23.6T	100%
	Coefficient of Variation (%)			7.50	10.74	4.96	7.11	9.59	4.74

@ Location 1 - Hayward Farm, Bay City, Michigan.
Location 2 - Bean and Beet Research Farm, Saginaw, Michigan.
Field plot design: Both locations were analyzed as randomized complete block experiments with six replications.
Plot size: 2 rows x 30 feet long (Loc.1); 2 rows x 33 feet long (Loc.2).

* Selected for bolting resistance (NB).

\+ Significantly above the General Mean

\- Significantly below the General Mean

AREA EVALUATION TESTS[@] - 1972 (cont.)

ENTRY No.	# White Su./Ton			Percent Sucrose			C. J. Purity (%)			Beet Stand/100ft.		
	Loc.1	Loc.2	Mean	Loc.1	Loc.2	Mean	Loc.1	Loc.2	Mean	Loc.1	Loc.2	Mean
	PERFORMANCE IN PERCENT OF THE TEST MEAN											
1	101.4	102.2	101.8	101.9	102.7	102.3	99.7	99.7	99.7	91.6	93.1	92.4
2	100.6	102.0	101.3	100.7	102.1	101.4	99.9	99.9	99.9	94.3	75.0-	84.6-
3	109.0+	102.5	105.7+	107.4+	102.5	104.9+	100.7	99.9	100.3	93.9	91.1	92.5
4	104.0	105.6	104.8+	103.7	104.7	104.2+	100.0	100.3	100.2	94.8	78.2-	86.5
5	100.0	100.2	100.1	99.8	99.5	99.6	100.1	100.4	100.3	101.3	94.5	97.9
6	97.5	94.6	96.0	98.4	96.3	97.4	99.5	99.1	99.3	91.2	90.3	90.8
7	108.7+	109.9+	109.3+	107.0+	107.1+	107.0+	100.7	101.3+	101.0+	101.3	92.7	97.0
8	102.9	102.3	102.6	102.5	100.9	101.7	100.2	100.8	100.5	87.5-	96.2	91.8
9	96.7	100.7	98.7	97.2	100.2	98.7	99.8	100.2	100.0	103.6	112.9	108.3
10	105.3+	105.1	105.2+	104.6+	104.1	104.4+	100.3	100.4	100.4	94.3	90.7	92.5
11	99.4	97.8	98.6	99.1	97.5	98.3	100.2	100.2	100.2	110.4	118.0+	114.2+
12	98.0	100.9	99.5	99.0	101.2	100.1	99.5	99.8	99.7	102.3	113.6+	108.0
13	101.9	103.6	102.7	101.6	102.7	102.2	100.1	100.4	100.3	108.3	107.7	108.0
14	96.9	100.1	98.5	97.9	100.7	99.3	99.5	99.7	99.6	95.6	88.9	92.2
15	102.3	98.8	100.5	102.1	98.9	100.5	100.0	100.0	100.0	99.9	97.6	98.7
16	101.9	104.8	103.3	101.4	103.8	102.6	100.2	100.5	100.4	97.2	86.7-	91.9
17	100.9	95.8	98.3	100.4	97.0	98.7	100.2	99.5	99.8	91.2	91.4	91.3
18	98.9	99.9	99.4	99.2	100.2	99.7	99.8	99.8	99.8	103.3	103.7	103.5
19	99.6	102.2	100.9	99.5	101.1	100.3	101.1	100.6	100.4	99.3	94.5	96.9
20	100.2	99.2	99.7	100.4	99.1	99.7	99.9	100.1	100.0	100.6	115.6+	108.1
21	96.6	95.5	96.1	96.6	96.2	96.4-	100.0	99.8	99.9	97.5	102.3	99.9
22	99.4	96.1	97.7	98.8	96.6	97.7	100.4	99.8	100.1	107.4	111.1	109.3
23	96.9	98.2	97.6	97.4	98.2	97.8	99.7	100.0	99.9	104.7	116.6+	110.6
24	99.8	101.7	100.8	100.1	101.1	100.6	99.9	100.3	100.1	98.2	105.7	102.0
25	98.8	92.3-	95.6-	100.0	95.8	97.9	99.3	98.2-	98.8-	101.3	98.2	99.7
26	93.3-	91.1-	92.2-	95.3-	94.2-	94.8-	99.0-	98.4-	98.7-	97.5	104.0	100.8
27	98.5	100.7	99.6	98.4	100.6	99.5	100.1	100.1	100.1	98.6	106.7	102.6
28	102.3	102.5	102.4	101.7	101.3	101.5	100.3	100.6	100.5	101.6	107.7	104.7
29	99.3	100.7	100.0	98.7	99.5	99.1	100.4	100.6	100.5	107.7	108.1	107.9
30	100.5	97.4	99.0	100.7	97.6	99.1	99.9	100.0	100.0	104.7	107.7	106.2
31	93.3-	91.6-	92.5-	94.3-	92.1-	93.2	99.6	100.0	99.8	104.7	113.2+	108.9
32	101.5	101.1	101.3	100.9	101.2	101.1	100.3	99.9	100.1	105.6	104.4	105.0
33	98.3	103.2	100.7	98.8	102.9	100.8	99.7	100.1	99.9	102.6	111.9	107.2
34	99.6	99.7	99.6	99.0	101.3	100.2	100.3	99.1	99.7	105.6	78.2-	91.9
35	98.3	98.0	98.1	98.0	98.0	98.0	100.2	100.1	100.1	95.9	81.2-	88.6
36	97.9	101.9	99.9	97.7	101.3	99.5	100.2	100.3	100.3	104.7	110.1	107.4
LSD	5.1	5.7	4.1	4.0	4.8	3.2	0.8	1.0	0.7	11.5	13.1	13.5
GM	278.1#	237.0#	100%	16.34%	14.48%	100%	94.92%	93.20%	100%	85bts	79bts	100%
CV	4.51	5.04	1.99	3.47	4.17	1.57	0.66	0.86	0.33	10.09	11.55	6.66

See preceeding page for footnotes

1972 NORTHERN OHIO SUGAR COMPANY, USDA VARIETY TEST, 2 LOCATIONS

4 x 4 simple lattice - four repl. - 2 rows x 15 feet harvested

HYBRID			Pounds Recoverable Sugar per Acre			Tons Beets/Acre			Percent Sucrose		
			Percent of Test Mean		Actual Mean	Percent of Test Mean		Actual Mean	Percent of Test Mean		Actual Mean
CMS	"0"	Pollen	Fremont	Old Fort		Fremont	Old Fort		Fremont	Old Fort	
SP7042-01		SP6822-0	105.4	103.8	4369.4	109.7	109.2	18.8	97.1	98.3	13.8
EL36		SP6822-0	95.1	92.9	3924.8	97.6	101.9	17.2	97.1	91.6	13.3
SP69550-01		SP6322-0	96.8	96.9	4047.9	94.8	94.9	16.3	101.2	102.5	14.3
SP69550-01	UI2161	SP6822-0	89.3	107.4	4135.6	88.9	105.4	16.8	100.2	101.8	14.2
SP6926-01	UI2161	SP6822-0	101.3	85.0	3870.7	107.3	87.5	16.7	94.4	98.3	13.6
SP69550-01	EL36	SP6822-0	92.9	107.9	4216.0	94.9	108.6	17.5	98.2	98.2	13.8
SP6926-01	EL36	SP6822-0	95.2	91.0	3885.0	103.6	98.3	17.4	94.2	93.0	13.2
SP69B5x02		SP6822-0	102.9	94.6	4115.0	105.2	99.2	17.6	98.4	95.4	13.6
SP69557-01	SP69550-0	SP6922-0	107.6	98.8	4300.0	102.2	91.4	16.6	104.9	105.6	14.8
SP6842-01	SP67550-0	SP6922-0	107.6	101.0	4349.0	104.2	100.7	17.6	103.1	100.6	14.3
SP69542-01	SP69550-0	SP6922-0	98.2	108.2	4325.2	94.1	104.2	17.1	104.5	103.1	14.6
SP6926-01	SP67550-0	SP6822-0(B)	98.2	97.1	4079.5	98.8	94.4	16.6	99.4	101.5	14.2
SP69550-01		SP6934-0	90.7	101.6	4031.9	85.5	95.7	15.6	104.2	105.2	14.7
SP69550-01		4n Multigerm	116.1	106.1	4627.5	111.5	101.6	18.3	101.9	103.1	14.4
SP67550-01		SP6822-0BR	102.8	107.7	4405.1	101.6	106.8	17.9	101.1	101.9	14.[illegible]
LSD 5% (for above data units)			NS	NS	NS	15.7	NS	NS	4.6	3.5	0.42
Test Means (Actual)			3910.0	4447.6	4178.8	16.6	17.8	17.2	13.8	14.4	14.1
Check Variety (Actual)			3598.6	4266.6	3932.6	15.8	17.5	16.7	13.4	14.1	13.8
Coefficient of Variation %			11.4	14.0	12.7	11.0	14.0	12.5	3.6	2.3	2.9

HYBRID			Percent Purity			Percent of Area Harvested			Actual Leaf Spot		Mean
			Percent of Test Mean		Actual Mean	Percent of Test Mean		Actual Mean			
CMS	"0"	Pollen	Fremont	Old Fort		Fremont	Old Fort		Fremont	Old Fort	
SP7042-01		SP6822-0	99.3	98.9	92.5	95.8	99.2	97.5	3.0	3.8	3.4
EL36		SP6822-0	99.8	99.4	92.9	97.5	87.5	92.5	1.8	3.8	2.8
SP69550-01		SP6322-0	100.2	99.9	93.4	100.0	98.3	99.2	1.5	2.5	2.0
SP69550-01	UI2161	SP6822-0	100.1	100.2	93.5	93.3	99.2	96.3	2.5	2.5	2.5
SP6926-01	UI2161	SP6822-0	100.1	99.8	93.3	93.3	96.7	95.0	2.8	3.8	3.3
SP69550-01	EL36	SP6822-0	99.9	100.4	93.5	83.3	95.8	89.6	1.8	3.5	2.6
SP6926-01	EL36	SP6822-0	99.3	99.7	92.8	95.0	100.0	97.5	1.8	3.5	2.6
SP69B5x02		SP6822-0	100.1	100.3	93.5	98.3	100.0	99.2	2.5	4.3	3.4
SP69557-01	SP69550-0	SP6922-0	100.2	100.9	93.8	98.3	100.0	99.2	1.3	1.8	1.5
SP6842-01	SP67550-0	SP6922-0	100.1	99.4	93.1	87.5	87.5	87.5	1.3	2.3	1.8
SP69542-01	SP69550-0	SP6922-0	100.0	99.9	93.3	73.3	100.0	86.7	1.3	2.0	1.6
SP6926-01	SP67550-0	SP6822-0(B)	100.3	100.2	93.6	95.0	99.2	97.1	1.5	2.5	2.0
SP69550-01		SP6934-0	100.2	100.6	93.7	100.0	100.0	100.0	1.0	1.3	1.1
SP69550-01		4n Multigerm	100.5	100.8	93.9	50.0	84.2	67.1	1.0	1.0	1.0
SP67550-01		SP6822-0BR	99.8	99.6	93.1	86.7	100.0	93.3	1.3	3.3	2.3
LSD 5% (for above data units)			NS	0.9	0.6						
Test Means (Actual)			92.9	93.7	93.3	89.8	96.5	93.2	1.7	2.8	2.2
Check Variety (Actual)			92.2	93.8	93.0						
Coefficient of Variation %			0.6	0.6	0.6						

VARIETY TEST, SAGINAW, MICHIGAN, 1972

6 replications, 1 row plots
22 feet long, 22 inches between rows

Holly Sugar Corporation
Planted: May 5, 1972
Harvested: October 2, 1972

Description	Extractable Sugar/Acre Pounds	Extractable Sugar/Ton Pounds	Gross Sugar/Acre Pounds	Beets/ Acre Tons	Sucrose Percent	Beets/ 100 ft. Number	Leaf Spot Grade
(U1100363 x SL133) x 6822	5,205	184.1	7,387	28.3	13.07	95	3.5
(69B5 x 02) x SP6822-0	5,112	181.2	7,293	28.3	12.92	98	2.5
Local Check FZM	5,095	193.8	7,099	26.2	13.52	99	3.5
(U1100363 x U112163) x 70P23	5,011	203.5	6,872	24.6	13.95	89	3.0
(6926-01 x EL36) x 6822	4,863	172.1	7,048	28.2	12.48	100	3.5
(U1100363 x U112163) x 70P21	4,834	196.7	6,711	24.6	13.65	94	2.5
(69550-01 x EL36) x 6822	4,829	188.1	6,808	25.7	13.25	94	3.5
(U1100363 x SL133) x 02 Clone	4,814	194.9	6,701	24.7	13.57	91	2.5
(U11861 x SL133) x 6822	4,697	195.0	6,537	24.1	13.57	92	3.0
Standard Check	4,627	188.5	6,519	24.6	13.27	95	4.0
EL36CMS x SP6822-0	4,512	173.6	6,535	26.1	12.55	88	3.0
FC506CMS x SP6822-0	4,304	180.7	6,145	24.0	12.87	95	2.5
69550-01 x SP6822-0	3,971	210.2	5,390	18.9	14.25	76	2.0
SP7042-01 x SP6822-0	3,829	180.8	5,476	21.3	12.90	87	2.5
Mean	4,693	188.8	6,608	25.0	13.27	92	3.0
LSD (0.05)	615	13.7	798	2.9	0.65	--	--
Coefficient of Variation - %	11	6.3	10	10.0	4.27	--	--
Standard Error of the Mean	218	4.9	282	1.0	0.23	--	--
F value	3.64**	5.07**	4.47**	6.48**	4.90**	--	--

VARIETY TEST, STANTON, MINNESOTA, 1972

6 replications, 1 row plots,
22 feet long, 22 inches between rows

Holly Sugar Corporation
Planted: May 9, 1972
Harvested: October 19, 1972

Description	Extractable Sugar/Acre	Extractable Sugar/Ton	Gross Sugar/Acre	Beets/ Acre	Sucrose	Beets/ 100 ft.	Leaf Spot
	Pounds	Pounds	Pounds	Tons	Percent	Number	Grade
(U1100363 x U112163) x 70P21	6,211	266.0	7,746	23.4	16.58	100	3.0
(U1100363 x U112163) x 70P23	6,198	261.8	7,776	23.7	16.42	95	3.0
(U11861 x SL 133) x 6822	6,040	254.8	7,647	23.7	16.13	99	3.0
(U1100363 x SL 133) x 6822	5,770	249.3	7,365	23.2	15.90	99	3.5
(U1100363 x SL 133) x 02 Clone	5,603	257.7	7,064	21.7	16.25	97	2.5
Local Check FZM	5,499	255.3	6,949	21.5	16.15	99	3.0
69550-01 x SP6822-0	5,368	264.8	6,707	20.3	16.53	96	2.5
EL36CMS x SP6822-0	5,338	241.5	6,898	22.2	15.58	98	3.0
SP7042-01 x SP6822-0	5,270	249.5	6,732	21.2	15.92	97	2.0
Standard Check	5,196	247.9	6,650	21.0	15.85	99	3.5
(6926-01 x EL36) x 6822	5,187	232.6	6,782	22.3	15.22	98	4.0
(69B5 x 02) x SP6822-0	5,048	242.2	6,514	20.9	15.62	99	2.0
(69550-01 x EL36) x 6822	5,033	252.3	6,395	19.9	16.03	97	3.5
FC506CMS x SP6822-0	4,806	247.2	6,154	19.5	15.82	93	3.0
Mean	5,469	251.6	6,956	21.7	16.00	98	3.0
LSD (0.05)	690	11.7	847	2.6	0.48	--	--
Coefficient of Variation - %	11	4.0	11	10.4	2.62	--	--
Standard Error of the Mean	244	4.2	300	0.9	0.17	--	--
F value	3.28**	5.08**	2.86**	2.27*	5.04**	--	--

VARIETY TEST, STANTON, MINNESOTA, 1972

6 replications, 1 row plots
22 feet long, 22 inches between rows

Holly Sugar Corporation
Planted: May 9, 1972
Harvested: October 10, 1972

Description	Extractable Sugar/Acre	Extractable Sugar/Ton	Gross Sugar/Acre	Beets/ Acre	Sucrose	Beets/ 100 ft.
	Pounds	Pounds	Pounds	Tons	Percent	Number
Local Check FZM	6,513	259.8	8,197	25.1	16.33	98
(67550-01 x 68750A) x 6922	6,125	257.7	7,731	23.8	16.25	97
(67550-01 x 68745A) x 6922	5,847	259.7	7,358	22.5	16.33	98
(6842-01 x 69550) x 6922	5,672	267.1	7,065	21.3	16.62	97
67550-01 x 6822-0 (BR)	5,657	264.7	7,064	21.3	16.53	98
68641-1 x 6822	5,525	248.2	7,055	22.2	15.87	98
69550-01 x 68442-65	5,503	268.6	6,836	20.5	16.68	97
(69542-01 x 69550) x 6922	5,483	277.4	6,731	19.7	17.03	97
69550-01 x 6934	5,482	272.8	6,775	20.1	16.85	98
(6426-01 x 67550) x 6822	5,406	256.1	6,831	21.1	16.18	99
FC506MS x SP6934-0	5,360	265.1	6,687	20.2	16.55	98
(69557-01 x 69550) x 6922	5,314	270.2	6,588	19.7	16.75	99
(69523-01 x 69550) x 6922	5,309	272.0	6,569	19.5	16.82	96
68608-1 x 6822-0 (P)	5,266	256.9	6,645	20.5	16.22	98
Standard Check	5,000	249.9	6,367	19.9	15.93	92
69550-01 x 67783-1	4,821	261.4	6,052	18.5	16.40	95
Mean	5,518	263.0	6,909	21.0	16.46	97
LSD (0.05)	817	11.2	1,000	3.0	0.45	--
Coefficient of Variation - %	13	3.7	13	12.5	2.37	--
Standard Error of the Mean	290	4.0	355	1.1	0.16	--
F value	1.95*	4.32**	2.13*	2.57**	4.28**	--

VARIETY TEST, STANTON, MINNESOTA, 1972

9 replications, 1 row plots
22 feet long, 22 inches between rows

Holly Sugar Corporation
Planted: May 9, 1972
Harvested: October 19, 1972

Description	Extractable Sugar/Acre	Extractable Sugar/Ton	Gross Sugar/Acre	Beets/ Acre	Sucrose	Beets/ 100 ft.	Leaf Spot
	Pounds	Pounds	Pounds	Tons	Percent	Number	Grade
Local Check	5,962	266.0	7,436	22.4	16.58	100	3.0
U11861 x 02 Clone	5,745	280.5	7,024	20.5	17.15	97	3.5
673465-01 x 6322-0	5,603	257.7	7,073	21.8	16.25	98	2.5
(U11861 x 6423) x 6822	5,562	264.4	6,956	21.1	16.52	99	3.0
6423-01 x 6322-0	5,495	258.9	6,912	21.2	16.30	98	3.0
673465-01 x 02 Clone	5,376	263.1	6,733	20.5	16.47	99	4.0
(U11861 x SL133) x 02 Clone	5,349	268.5	6,646	19.9	16.68	100	4.0
(6423-01 x 673465) x 02 Clone	5,329	257.3	6,716	20.6	16.23	99	3.0
6423-01 x 6528-01	5,269	248.7	6,728	21.2	15.88	99	3.0
(U11861 x 6423) x 02 Clone	5,253	266.1	6,549	19.7	16.58	98	3.0
Standard Check	5,170	251.5	6,588	20.6	16.00	98	4.5
(6423-01 x 673465) x 6822	5,156	261.1	6,459	19.6	16.38	98	2.0
(6423-01 x 6621) x 02 Clone	5,078	258.1	6,400	19.7	16.27	98	3.0
6423-01 x 02 Clone	5,015	250.3	6,398	20.1	15.95	99	3.0
Mean	5,383	260.9	6,758	20.6	16.37	99	3.2
LSD (0.05)	0	9.9	0	0.0	0.40	--	--
Coefficient of Variation - %	15	3.3	15	14.8	2.12	--	--
Standard Error of the Mean	324	3.5	404	1.2	0.14	--	--
F value	NS	5.61**	NS	NS	5.53**	--	--

Screening Breeding Lines for Disease Resistance, East Lansing, 1972

C. L. Schneider and G. J. Hogaboam

1. Black root disease - In a series of 18 screening tests conducted in the greenhouse, 187 breeding lines were screened for resistance to the beet water mold, *Aphanomyces cochlioides*. Dried oospore-vermiculite inoculum was applied to each pot at time of seeding. Inoculum was prepared as follows: mycelial mats, produced in .5% oatmeal broth, adjusted at pH 6.5, were homogenized with water in a blender. After spore density had been determined with a Howard spore counting chamber, the desired spore concentration was obtained by diluting with an appropriate amount of water. The resultant spore suspension (1 part) was mixed with vermiculite (2.5 parts) V:V, then spread out in paper-lined trays to thoroughly dry. Oospore dosage/pot ranged from 14.4-52.5x10^3 spores, with the number varying with replicate block and experiment. Subsequent tests have indicated, however, that 10x10^3 spores/4-in. pot are adequate. Each test of 12 entries included commercial variety US H20 as a standard for comparison and five replicated pots of each entry. Within 6 weeks after planting, plants were numerically rated according to disease severity from 0 (no symptoms) to 5 (dead) and average ratings were computed. The average disease rating of US H20 in all tests ranged from 2.70 - 4.78. The percentage of entries with ratings significantly lower (more resistant) than US H20 = 9.6% and those significantly higher (more susceptible) = 3.8%. The remainder were rated equal in resistance to US H20, a relatively resistant variety.

2. Rhizoctonia root rot - Entries were tested for resistance in field plots artificially inoculated with *Rhizoctonia solani*. There were 4 experiments, each comprising 33 entries and 3 check varieties; (1861x2161) x6322-0, (100363x2161)x6322-0, and SP69550-01x6322-0. In each experiment were 3 single-row plots, 20 ft long of each entry. In addition, 22 lines derived from crosses with Rhizoctonia-resistant lines were grown in special plots for observation and selection. Throughout the nursery were special observational plots of varieties 5831-0 (Rhizoctonia-resistant selection from a black root resistant line), SP6822-0 (highly susceptible to Rhizoctonia) and FC701/5 (resistant to Rhizoctonia). Shortly after blocking, all plots were infested with dried barley grain inoculum applied mechanically about 4 in. to the side of each plant row at the rate of 3 ml/ft of row. Since incidence of root rot appeared to be low approximately one month after the side dress inoculation, - probably because of the drought conditions that then prevailed, - crown inoculations were made at the rate of 5 ml/ft of row on 19 July in some blocks and on 14 August in others. Crown rot symptoms developed shortly thereafter with fairly high incidence. On 2 October all plots were evaluated according to incidence and severity of above-ground symptoms. A numerical disease rating for each plot was computed according to the formula:

$$\frac{.5\text{x(no plants diseased)}+1.0\text{x(no plants dead since post-blocking count)x}100}{\text{post-blocking stand}}$$

Disease ratings ranged from 90.3 for the most susceptible entry to 8.3 for the most resistant. The average combined ratings of the 3 check varieties in Experiments 1, 2, 3 and 4 equaled 58.7, 44.3, 60.3 and 67.9, respectively. Differences in reaction to R. solani infection among the 3 varieties in the observational check plots were striking (Fig. 1). The number of entries in each experiment with disease ratings significantly lower than the combined average of the 3 check varieties were as follows: Experiment 1 (mm lines from Beltsville) = 3; Experiment 2 (East Lansing MM lines) = 2; Experiment 3 (East Lansing MM and mm lines) = 6; Experiment 4 (progeny of selections for Rhizoctonia resistance at East Lansing and Fort Collins) = 17. Among the 19 entries in the selection plots comprising the progeny of black root and Rhizoctonia-resistant 5831-0x0-type mm lines, 9 had ratings significantly lower (more resistant) than the 3-check average. The average rating of 64 plots of F_2 progeny of the cross, FC702/2x6822-0 equaled 32.9, compared with that of nearby plots of 6822-0 which equaled 60.0. Selections for Rhizoctonia resistance were made among entries with disease ratings significantly lower than the 3-check average.

3. Cercospora leaf spot - In the Cercospora leaf spot disease nursery were 7 experiments each comprising 33 entries replicated 3 times in single-row plots 20 ft long. Each experiment included the 3 check varieties (1861x2161)x6322-0, (100363x2161)x6322-0 and SP69550-01x6322-0 as standards for comparison. Inoculum, consisting of dried and ground sugarbeet leaves infested with Cercospora beticola, was applied with a knapsack crop duster on 26 June, at the rate of 49 liters/acre. Disease symptoms were apparent by 11 July. Disease severity ratings, based on a numerical index from 0 (no symptoms) to 9 (complete defoliation) were made on a plot basis on 25 August and 6 September. The number of entries in each experiment rated more resistant than the average of check varieties (1861x2161)x6322-0 and (100363x2161)x6322-0 were as follows: Experiment 1 (Beltsville MM lines) = 31; Experiment 2 (Beltsville mm lines) = 28; Experiment 3 (East Lansing MM lines) = 28; Experiment 4 (East Lansing mm lines) = 29; Experiment 5 (Rhizoctonia-resistant lines from East Lansing and Fort Collins) = 11; Experiment 6 (East Lansing experimental hybrids) = 5; Experiment 7 (East Lansing experimental hybrids) = 4. In each experiment, check variety SP69550-01x6322-0 received a rating significantly lower (more resistant) than the average of the other 2 check varieties. Plants were selected for leaf spot resistance from among the entries with average ratings significantly better than that of the 3 check varieties.

Fig. 1. Roots harvested from an observational check plot in East Lansing Rhizoctonia nursery. Sugarbeet lines in rows from top to bottom: Rows 1-2: FC701/5 - a Rhizoctonia-resistant line developed at Fort Collins; Rows 3-4: 6822-0 - a variety with no history of selection for Rhizoctonia resistance; Rows 5-6: 691006-0, derived from Rhizoctonia-resistant selections from black root and leaf spot-resistant line 5831-0 at Fort Collins.

SUGARBEET DISEASE INVESTIGATIONS AT EAST LANSING IN 1972

C. L. Schneider

1. Blackroot disease (Aphanomyces cochlioides).

a. Soil treatments - In a field plot naturally infested with the beet water mold, A. cochlioides, the following materials were applied in a 4-in. band along the drill row before planting and incorperated into the soil at a depth of about 2-in. at indicated lb/A:dried and ground cabbage, 165, 330 and 660 lb; sodium-p-(dimethylamino)benzenediazo-sulfonate 35W, 2.8 lb; gypsum, 325 and 650 lb; limestone, 650 lb; tri basic copper sulfate 53W, 3.5 and 14.0 lb. Under relatively severe incidence of seedling blight, no significant differences in stand between controls and any of the above treatments were noted.

b. Production of oospores - In vitro production of oospores in a chemically defined medium was demonstrated. The synthetic medium of Yang and Schoulties (Mycopath. et Mycol. Applicata 46: 5-15, 1972) was employed. With this medium, oospore production was accelerated and enhanced by replacing the nutrient medium with a non-nutrient medium after 4 days growth of the cultures. Well water proved to be a more effective replacement substrate than salt solutions, tap water or distilled water.

c. Longevity of oospores - Evidence was obtained that A. cochlioides can retain viability for relatively long periods at a range of temperatures. Dry vermiculite cultures, rich in oospores, were highly infective in pots of sugarbeet seedlings after they had been stored at one of the following temperatures: -9, 4 and 25° C, for a period of 18 months.

d. Inoculation of field plots with oospores - Varying concentrations of oospores in dry vermiculite were applied in the drill row immediately before planting. The losses in seedling stands from 27 June until 17 July associated with each dosage of oospores (no. of oospores/ft of row) were as follows: 0 spores (control) = -5%; $36x10^3$ spores = -9.8%; $81x10^3$ spores = -9.3%; $136x10^3$ spores = -11.5%. The relatively small differences in seedling loss associated with the different treatments indicate that inoculum dosages may not have been high enough or environmental conditions during the extremely dry period that prevailed shortly after inoculation were not conducive to infection.

2. Rhizoctonia root rot (Rhizoctonia solani).

a. Pathogenicity of isolates - Studies were continued to determine the existence of pathogenic strains of Rhizoctonia solani attacking sugarbeet. Among 45 cultures previously isolated from rotted roots of commercial variety US H20, no pathogenic strains capable of overcoming

the resistance of cultivars FC701 and FC702 were noted. Currently, the pathogenic capabilities of cultures isolated from roots of resistant cultivar FC701 are being investigated in tests on sugarbeets and on other crops commonly grown in the North Central area.

b. Methods of inoculation - The efficacy of various types of Rhizoctonia inoculum and methods of placement in field plots were compared. Dried barley grain inoculum applied in crowns (2.5 ml/ft of row) immediately after blocking was superior to other inoculation methods in initiating infection to screen Rhizoctonia-resistant and susceptible sugarbeet types. Other methods tested, in order of efficacy, included barley grain inoculum applied in crowns one month after block; and barley grain inoculum side dressed immediately after blocking (5 ml/ft of row). Dried vermiculite cultures side dressed or applied in the crowns were ineffective. The exceptionally dry soil conditions that prevailed during early summer may have reduced the effectiveness of the side dress applications inasmuch as a higher degree of infectivity has been obtained with this method of inoculation under more favorable conditions.

c. Fungicide test - The efficacy of chemical sprays applied in the crowns to control Rhizoctonia root rot was studied in field plots artificially infested with the fungus. It is believed that the drought conditions prevailing immediately after application of the ground barley inoculum in the soil adjacent to the plant rows caused resulting disease incidence to be relatively light. Each of the chemical spray treatments were applied three times at 21-day intervals commencing 6 June. In October, the average root rot rating of each 20 ft plot, based on a numerical index ranging from 0(no symptoms) to 4(dead) was computed. Root rot ratings of each treatment at indicated dosages (aia) expressed as means of 4 replicate plots were as follows: benomyl, 4 oz = .7; benomyl 6 oz = .5; chloroneb, 2 lb = .4; chlorothalonil, 1.5 lb = .1; carboxin, 1.5 lb = .4; carboxin, 12 oz + thiram, 12 oz = .3; hexachlorophene, .75 fl oz = .4; hexachlorophene, 1.5 fl oz = .7; PCNB, 2 lb = 1.0; triphenyltin hydroxide, 4.75 oz = .5; untreated control = .9. Although the relatively low disease incidence appeared to be inadequate for comparison of all treatments, the extremely low rating associated with chlorothalonil treatment may be indicative of its control potential inasmuch as this compound provided outstanding control in a similar test conducted in 1971.

3. Cercospora leaf spot (*Cercospora beticola*).

a. Fungicide screening tests - Two experiments were conducted in field plots of variety US H20 artificially infested with dried sugarbeet leaf inoculum, applied at 49.2 liters/acre. In Experiment 1, the efficacy of 11 fungicides at various dosages and spray schedules was tested. Surface protectants as well as systemic compounds were included. In Experiment 2, the efficacy of foam application of benomyl was tested. Foam, as a fungicide carrier would be especially desir-

able in aerial applications because it reduces drifting of the spray and consequently increases the likelihood of a fungicide reaching the target. Beginning 19 July a total of 4 spray applications were made at 14-day intervals and 3 were made at 21-day intervals. Sprays were applied with a CO_2-activated, hand-operated sprayer in 60 gal. water /acre. Foam applications were made by the addition of a foaming agent at indicated rate and by the use of special nozzles. Each plot comprised two rows, 20 ft long in Experiment 1 and 60 ft long in Experiment 2. Plots were graded according to disease severity on 28 August and 6 September. All of the treatments in Experiment 1 reduced leaf spot damage significantly below that of the control (Table 1). Benomyl (2 and 4 oz a.i.a.) and thiophanate methyl (2.8 oz + spreader-regulator and 5.6 oz a.i.a.) were outstanding among the treatments, even at 21-day schedules. In Experiment 2, foam application of benomyl was just as effective as conventional aqueous spray application and no phytoxicity symptoms were noted.

b. Aerial application of fungicides - In experiments conducted cooperatively with H. S. Potter, Michigan State University and with the Northern Ohio Sugar Company, aerial application of several surface protectant and systemic fungicides with several spray adjuvants was tested. Sprays were applied by fixed wing aircraft at 5 gal./acre after disease symptoms had been noted. Experiments were conducted in two commercial fields near Monroe, Michigan and one near Old Fort, Ohio. Treatments were replicated twice and applied to plots wide enough to accommodate 3 passes with the aircraft and ranging in length from 80 rods to .3 mile according to the experiment. Determinations of leaf spot severity made 25 September indicate good disease control with all treatments (Table 2). Root weight data obtained from six 10-ft sampling strips per plot show average increase in root yield of treated vs untreated plots at Haack farm = + 24%; at Greening farm = 30%; at Molyet farm = 25%. No significant differences in percent sucrose were noted between any treatments at any location. At Old Fort, the addition of a foaming agent substantially reduced lateral spray drift and appeared to improve spray deposition on foliage with no indication of impairment of fungicide effectiveness or phytoxicity.

Table 1. Results of tests with fungicides to control Cercospora leaf spot disease of sugarbeet at East Lansing in 1972.

Treatment and rate (a.i.a.) and (per 100 gal.)	Spray frequency (days)	Disease severity rating[1/]	
		Aug. 28	Sept. 6
<u>Experiment 1</u>			
Benomyl 50W, 2 oz	21	0.9	1.1
Benomyl 50W, 2 [redacted] + oil, 2 qt	21	0.8	1.7
Benomyl 50W, 4 oz	21	0.5	0.4
Chlorothalonil 6F, 1.13 lb	14	2.5	3.1
Chlorothalonil 75W, 1.13 lb	14	1.5	2.6
Chlorothalonil 75W, 1.13 lb + spreader-sticker, 1 qt	14	2.0	2.4
Chlorothalonil 75W, 1.5 lb	14	2.0	2.8
Cupric hydroxide (56% Cu)W, 1.12 lb	14	2.4	2.5
Cupric hydroxide (56% Cu)EC 1.12 lb	14	2.8	3.1
Cupric hydroxide (56% Cu)EC 2.24 lb	14	2.3	2.5
Cuprous oxide 75W, 2.15 lb	14	2.8	3.5
TBZ 42.28EC, 2.85 oz	14	1.4	2.0
Thiophanate methyl 70W, 2.8 oz	14	0.9	1.7
Thiophanate methyl 70W, 2.8 oz	21	1.0	2.3
Thiophanate methyl 70W, 2.8 oz + spreader-regulator, 1 qt	21	0.8	0.6
Thiophanate methyl 70W, 4.2 oz	14	1.4	1.8
Thiophanate methyl 70W, 4.2 oz	21	2.0	2.5
Thiophanate methyl 70W, 5.6 oz	21	0.9	0.9
Triphenyltin hydroxide 47.5W	14	1.9	2.3
Triphenyltin hydroxide + zineb 18.5 + 18.5W, 10.8 oz	14	2.1	2.9
Zineb (25%) + S (20%) + Cu (5%)W, 2.15 lb	14	2.5	3.6
Control		3.5	4.5
	LSD (.05)	0.7	0.9
<u>Experiment 2</u>			
Benomyl 50W, 2 oz	21	1.5	1.1
Benomyl 50W, 2 oz + Foaming agent, 2 qt	21	1.2	0.8
Control		3.5	4.5
	LSD (.05)	0.5	0.6

[1/] Ratings based on a numerical index from 0(no symptoms) to 9(complete defoliation). Results are based on four replicated plots, each comprising two rows, 20 ft long in Experiment 1 and 60 ft long in Experiment 2.

Table 2. Control of Cercospora leaf spot disease with aerially applied fungicides at three locations in 1972.

Location, type of treatment and dosage (a.i.a.)		Disease rating[1/]
I. Haack farm, Monroe, Michigan, 3 applications, 2 weeks apart.		
Cupric hydroxide EC, 1.72 lb + Sticker-spreader, 2 oz		2.2
Cupric hydroxide W, 1.72 lb + Sticker-spreader, 2 oz		1.5
TBZ 42.38EC, 3.4 oz		2.3
Control		4.9
	LSD (.05)	1.0
II. Greening farm, Monroe, Michigan, 3 applications, 2 weeks apart.		
Cuprous oxide 75W, 1.5 lb + Sticker-spreader, 2 oz		1.4
Tribasic copper 53W, 1.06 lb		1.1
Tribasic copper 53W, 1.06 lb + oil, 1 qt		1.7
Control		4.4
	LSD (.05)	1.3
III. Molyet farm, Old Fort, Ohio, 2 applications, 3 weeks apart.		
Benomyl 50W, 4 oz		0.7
Benomyl 50W, 4 oz + foam agent, 2 qt		0.9
Triphenyltin hydroxide 47.5W, 4.75 oz		1.4
Triphenyltin hydroxide 47.5W, 4.75 oz + foam agent, 2 qt		1.4
Control		4.4
	LSD (.05)	0.9

1/ Disease ratings expressed as means of two plots and are based on an index from 0(no symptoms) to 9(complete defoliation).

STORAGE CHARACTERISTICS OF INDIVIDUAL ROOTS WITHIN SEVERAL BREEDING LINES

R. C. Zielke

Impurity constituents in stored beet roots may vary considerably depending upon the length of storage time, temperature, agronomic practices, and varietal characteristics. The more dynamic impurities in stored roots in Michigan are reducing sugars (invert) and raffinose. Smaller flucuations may occur in the amino acid, potassium and sodium fractions.

Roots of several breeding lines were analyzed after storage to determine relative differences between roots and between breeding lines. If differences are great enough, then selection methods might be used to develop new lines which would store considerably better than present varieties.

Roots for this preliminary study were harvested as mother roots in October, 1970 and held at 40 F in small fruit crates having a poly liner. Dry wood chips were spread around the roots inside the closed liner to control excessive moisture. Roots were kept in storage until August, 1971, then unpacked and the rotten or partially rotten were discarded. The DFS Method (1) was used for clarifying and analyzing the juice samples from each root. Raffinose and reducing sugars were determined with methods reported by Dexter, et al (2).

Table 1 gives the results of these analyses. No fresh data were available for each root for comparative purposes, but agronomic results of roots harvested from similar lines in the same field indicated that clarified juice purities (% CJP) ranged between 90 and 96%. Roots in this study ranged between 9.8 and 16.5 in sucrose content, 61.2 and 94.5 in % CJP, 68 and 1940 mg raffinose/100g sugar, 969 and 46,537 mg reducing sugars/100g sugar, and 5 and 272 pounds of recoverable white sugar per ton (RWST). The ranges in quality and impurities were very large between roots and, to a considerable extent, between breeding lines (line A vs. line C, for example). One would surmise from these results that considerable heterogeneity may exist in breeding lines for loss of sucrose through respiration and conversion, loss in CJP from lower sucrose and/or buildup in impurities, and gains in raffinose and reducing sugars.

Table 1. Performance[1] of individual roots of several breeding lines after 270 days storage at 40 F.

Breeding Line	Root No.	Sucrose Content	CJP	Raff.	Red. S	RWST[2]
		(%)	(%)	mg/100gS	mg/100gS	Lbs/T
A	1	9.8	62.6	1255	42,933	14
	2	10.4	61.2	855	46,537	5
	3	12.7	72.0	197	31,831	91
B	1	14.0	84.7	139	14,385	182
	2	14.3	91.4	115	1,802	221
C	1	14.5	82.7	1422	17,423	178
	2	16.4	94.5	68	1,474	270
	3	15.8	93.1	181	2,720	254
	4	16.5	94.2	113	1,573	272
	5	16.2	93.6	94	1,448	263
	6	16.5	93.2	149	2,026	265
D	1	12.5	77.4	1042	19,695	124
	2	12.7	86.1	131	7,466	171
	3	10.5	76.5	980	17,654	99
E	1	14.5	90.8	77	2,733	222
	2	13.4	78.9	1177	22,480	144
F	1	12.9	86.1	758	8,305	175
	2	13.3	86.6	616	6,972	183
	3	11.9	72.4	1382	29,218	88
G	1	12.1	82.4	1344	11,628	146
	2	11.1	75.0	1940	21,447	96
H	1	15.8	92.9	150	2,540	253
	2	13.1	84.7	326	7,706	170
	3	12.2	78.8	731	18,620	128
	4	14.0	89.7	126	1,924	207
	5	13.8	92.2	139	969	217
	6	13.6	88.9	165	5,086	198

[1] Where applicable, polarimetric values were adjusted for the rotational effects of reducing sugars and raffinose. (J. ASSBT 15(6): 480-488).

[2] Calculated using M. G. Frakes' Standard Research Formula for fresh beet. (Michigan Sugar Co. Research Laboratory)

Correlation coefficients between the quality factors and impurities are shown in Table 2.

Table 2. Correlation coefficients between quality and impurity characteristics for individual roots of several breeding lines after 270 days storage at 40 F.

	CJP	Raff.	Red. S.
% Sucrose	0.88**	-0.48*	-0.78**
CJP		-0.60**	-0.98**
Raff.			0.60**

** significant at the 1% level
* significant at the 5% level
ns not significant

Identification of the best roots after 9 months storage at 40 F could be accomplished with a test for CJP. Coefficients between CJP and reducing sugars and % sucrose are very high and are also quite indicative of raffinose content. In a previous study (unpublished data - 1971, Zielke) where 14 roots of 1 subline were analyzed after 135 days storage at 40 F, correlation coefficients between CJP and other characters were as follows: % sucrose (0.84**), reducing sugars (-0.98**), raffinose (-0.51**), amino acids (-0.34 ns), potassium (-0.34 ns), and sodium (-0.03 ns). Correlations between individual root weights and other characters for this small study were as follows: % sucrose (-0.27 ns), CJP (-0.11 ns), reducing sugars (0.10 ns), raffinose (0.34 ns), amino acids (-0.25 ns), potassium (0.24 ns), and sodium (0.53**). Although it appears that size of selected and stored roots would not influence determinations for quality and impurities, the problem of maintaining yielding ability in subsequent generations may exist unless large numbers of roots are propagated from a selection on storage quality (% sucrose or CJP).

Literature Cited

(1) Dexter, S. T., M. G. Frakes, and F. W. Snyder. 1967. A rapid and practical method of determining extractable sugar - - -. J. ASSBT 14(5): 433-454.

(2) Dexter, S. T., M. G. Frakes, and R. E. Wyse. 1969. Damage to sugarbeet roots from various degrees of wilting at various temperatures. J. ASSBT 15(6): 480-488.

PHYSIOLOGICAL INVESTIGATIONS - 1972

F. W. Snyder

Germination and Emergence Studies

R. C. Zielke collaborated in these studies.

A summary of significant findings follow:

1. The simplified gravel emergence test, reported previously, has proven to be unsatisfactory because we found that the water clinging to the gravel varied sufficiently to affect emergence. Emergence of a commercial seedlot hypersensitive to water was erratic and it could be suppressed significantly if the gravel was not drained sufficiently. If addition of water to the gravel has to be carefully controlled, the major advantage of using gravel is lost.

2. We now feel that fine quartz sand (1 to 0.1 mm) at 4% moisture provides a better system, since 4% moisture did not adversely affect emergence of the hypersensitive seedlot. Seeds are placed at a depth of 1½ inches.

3. The hypersensitive seedlot germinated about 80% on blotters having regular moisture, but would germinate about 90% on blotters kept relatively dry. As blotter moisture increased to very wet, germination was suppressed to about 70%. These and additional results will be reported in a manuscript currently in review.

Data (Table 1) for 4 seedlots from individual plants indicate the following:

a) Blotter germination is not a good indicator of emergence potential and it is less sensitive than emergence from sand in detecting the adverse effects of premature harvests.

b) Although the 10-day germination data for the 50-day harvest indicates that these 4 seedlots were mature, the sand emergence data indicate that none of these seedlots were physiologically mature at 50-days, based on both speed of emergence and total emergence.

c) Based solely on blotter germination data, the 4 seedlots would be rated as excellent, but based on the sand emergence data, only seedlots A1-58 and A13-65 would be rated excellent.

d) The data suggest that physiological maturity as measured by 10-day blotter germination occurs earlier than physiological maturity as measured by emergence from sand.

e) Since we seek maximum emergence potential under field conditions, the sand emergence test should evaluate this potential more critically than blotter germination.

f) Time of harvest in relation to seed performance needs to be studied further and we believe that harvest should be based on degree days or heat units to attain a greater uniformity of maturity and better seed performance.

g) We now have evidence that the lower emergence potential of seed of two different plants (A19-611, A21-511) is not related to the degree of maturity.

Table 1. Effect of maturity on blotter germination and sand (4% moisture, seed depth 1½ in.) emergence of processed sugarbeet seeds from individual plants.[1]

Harvest after first bloom	Seedlot A1-58				Seedlot A13-65			
	Germination		Emergence		Germination		Emergence	
	3-day	10-day	7-day	12-day	3-day	10-day	7-day	12-day
Days	%	%	%	%	%	%	%	%
40	15	38	2	8	8	54	14	27
45	58	88	28	43	56	80	31	45
50	88	100	32	56	78	95	55	79
55	93	97	75	89	89	96	72	90
60	99	100	79	96	99	100	79	93
65	99	100	84	98	99	100	77	98
70	100	100	95	98	95	96	91	98
75	96	100	97	98	95	98	75	90
	Seedlot A19-611				Seedlot A21-511			
40	43	95	2	35	13	93	27	36
45	74	89	32	66	-	-	-	-
50	73	95	25	64	58	99	52	66
55	93	96	32	71	-	-	-	-
60	96	99	31	66	54	100	52	77
65	98	100	33	72	-	-	-	-
70	99	100	29	66	60	100	56	78
75	95	100	32	75	-	-	-	-

[1] Percentages not corrected for non-viable seeds.

Leaf-area Accretion Studies

Additional data are being accumulated but results are incomplete, therefore no report can be made on new phases of study at this time.

In a more detailed analysis of data presented in Table 3, page E38 in the 1971 Sugarbeet Research Report, the following rationale was used. If we assume that the efficiency of a sugarbeet plant is an important component of yield and that in the seedling stage efficiency can be expressed as a ratio derived from

$$\frac{\text{Root weight in grams}}{\text{Leaf area in cm}^2} \quad \text{or from} \quad \frac{\text{Root weight in grams}}{\text{Leaf blade weight in grams}}$$

then the larger the ratio, the more efficient the leaves are in producing root weight. Other questions follow: Do cultivars differ in this efficiency? Do the smallest seedlings and the largest seedlings within a given cultivar differ in efficiency? Are trends, if any, consistent?

The mean ratios for Exp't 28 and 41 (Table 2) differ by about a third. This suggests that cultivars may actually differ in the efficiency with which they produce root weight. The range in the ratios for individual plants of 02 Clone exceeded 2-fold and for US H20 3-fold. The fact that the ratios differ much more for individual plants within a cultivar than the averages between cultivars is, in my opinion, a very important observation. This large variability suggests that, at least for sugar beets, there is a good chance that re-selection within the components of a hybrid could improve the overall efficiency and increase yield for the redesigned cultivar. The possible heritability of such traits needs to be investigated.

With the possible exception of cultivar B, (Table 2) the plants with the largest leaf area or weight seem to produce seedling root weight at least as efficiently as those with the smallest leaf area and weight. Uniform plants are not available, and reliable experimental techniques are not readily available to relate seedling root size to root size of the same plant at the end of the growing season, thus it may be difficult to carry out definitive research on this relationship.

Physiology of Hybrid Vigor and Inbreeding Depression of Vigor:

Elucidation of the physiological mechanisms controlling plant vigor is a major biological challenge and should aid man in producing more food and fiber. The sugarbeet exhibits a wide range in vigor and has some other attributes useful in these studies.

The study, undertaken this year, has encountered some minor problems, but progress has been made in developing nutrient media to support good growth of explants of root tissue. Two immediate objectives are 1) to determine whether differences in growth in culture can be detected be-

tween slow-growing highly inbred parents and their vigorous F_1's, and 2) to develop genetically uniform plantlets for use in physiological and pathological research.

Table 2. Seedling leaf and root production of some sugarbeet cultivars grown in growth chambers for 25 to 30 days after emergence.

Exp't. no.	Cultivar	No. plants averaged	Leaf area	Leaf wt.	Root wt.	Ratio Root wt./Leaf area	Ratio Root wt./Leaf wt.
			Cm^2	G	G		
28	US H20#	5 smallest	349	16.4	1.90	0.0054	0.1159
		5 largest	574	23.5	3.56	0.0062	0.1515[a]
29	A	4 smallest	630	26.0	2.98	0.0047	0.1146
		4 largest	970	41.1	4.36	0.0045	0.1061
29	B	4 smallest	514	19.5	2.44	0.0047	0.1251
		4 largest	859	33.2	3.36	0.0039	0.1012
30	C@	4 smallest	485	22.3	2.35	0.0048	0.1054
		4 largest	753	32.0	3.37	0.0045	0.1053
30	D	4 smallest	449	18.5	1.60	0.0036	0.0865
		4 largest	731	31.1	2.99	0.0041	0.0961
41	02 Clone#	5 smallest	365	14.2	1.32	0.0036	0.0930
		5 largest	763	30.9	3.05	0.0040	0.0987[b]

based on 40 plants, @ on 18 plants, all others on 20 plants.

[a] mean ratio for 40 plants 0.1528 ± 0.0422

[b] " " " " " 0.1004 ± 0.0218

BREEDING SUGARBEETS FOR RESISTANCE TO BLACK ROOT AND LEAF SPOT

G. E. Coe

Research work on sugarbeets at the Plant Industry Station, Beltsville, Md. is directed mainly toward varietal improvement in resistance to Aphanomyces black root and Cercospora leaf spot, important diseases in eastern United States.

Highlights of the work at Beltsville are set forth in this report.

Progress Report on New Nursery Testing Techniques

The new method of space planting the Beltsville sugarbeet leaf spot nursery at 4 and 6 inch spacing in 2 ft. rows (see p. E68 of 1971 Sugarbeet Research Report) was used again in 1972. Conditions for seed germination were poor. A beating rain 4 days after planting formed a hard crust on the soil surface. This crust was softened and kept soft with sprinkler irrigation until the seedlings emerged. A satisfactory stand for leaf spot testing was obtained but emergence was only about 60% to 70% for most lines tested. Early weed control was good, but it was necessary to hoe the plots twice between July 10 and Aug. 1. This poor weed control in midseason was partially due to excessive rainfall which washed post-emergence herbicides from the soil. A severe leaf spot epidemic was produced in 1972, and the leaf spot nursery test was considered very good. The new method for planting and handling the Beltsville sugarbeet nursery are considered the best we have used and will be continued until means of improving them are devised.

One change was made this year in obtaining pulp from 10 root samples. The beets were run through the rasp without removing the crowns. The reasoning that prompted this change is: testing should be made on the type of material closely approximating that which goes into the factory. The overall sucrose percentage and purity of root and crown should be the basis for comparing both hybrids and breeding lines.

Breeding for Black Root Resistance

Greenhouse tests in 1972 indicate that progress is still being made in improving resistance to Aphanomyces black root disease. In 1971, I reported that a new elite multigerm line SP 6934-0 exhibited outstanding resistance to black root. This line is now being used as the resistant check in the black root testing program. Approximately 5% of the 1971 multigerm breeding lines exhibited more resistance to black root than SP 6934-0. The average black root resistance of the 1971 lines appeared to be about 4 points (in a 50 point range) better than the average of the 1969 lines. It is doubtful that the actual increase in resistance was this great, but no doubt some improvement was made. Nursery tests indicate that yield potential of the breeding lines has decreased slightly when grown in the absence of black root and leaf spot diseases. Great emphasis will now be given to increasing

root yield potential. This will probably result in a much slower rate of improvement in disease resistance, sucrose percentage and purity, but yielding potential must not be allowed to decline further.

Progress in Improving Leaf Spot Resistance

The leaf spot epidemic in the 1972 Beltsville sugarbeet nursery was the most severe it has been in many years, resulting in an apparent better separation of degrees of resistance among the most resistant breeding lines. The average resistance of the breeding lines, however, appears to be no better than it was in 1970 indicating no significant improvement. It would be erroneous, however, to conclude from one year's results that selections for resistance are only maintaining the present resistance level. Lines which would have appeared to have excellent resistance under a less severe epidemic probably exhibited only good resistance in 1972 bringing the overall average of the breeding lines down somewhat. Even so, this average resistance is much better than the resistance of existing commercial hybrids, and the most resistant breeding lines approach field immunity.

Testing of Globe-Shaped "Sugarbeets"

The 5 globe-shaped hybrids tested in observational plots in 1971 and 2 additional ones were tested in observational plots in 1972. The rows were spaced 6" apart and the seeds were spaced 6" apart in the row. The results were disappointing again this year.

Variety	Roots T/A	Sucrose %	Other Solubles %	Plant Population Plants/Acre
69550-01 X 6322-0	8.01	15.5	3.45	62,200
Hybrid #1	8.93	10.8	3.31	53,500
" #2	8.34	11.8	3.23	59,100
" #3	7.34	11.4	3.17	54,800
" #4	11.54	13.7	3.20	95,800
" #5	6.00	10.7	3.04	54,100
" #6	6.63	11.2	3.60	67,200
" #7	7.84	11.5	3.07	61,600

Root yields including the check plot were extremely poor ranging from 6.0 to 11.5 tons per acre. This is a sharp contrast indeed to last year's 19 to 28 ton yields. Adjacent plots of sugarbeet breeding lines planted in 2 ft. rows with 6" spacing of seeds yielded about 15 tons per acre.

Sucrose percentages gave the same picture as in 1971. The sugarbeet hybrid was much better than the globe-shaped hybrids. The percentage of soluble nonsucrose solids also gave the same picture as in 1971. The globe-shaped hybrids were lower in these constituents than was the sugarbeet hybrid. However, the content of soluble nonsucrose solids will

undoubtedly increase as the sucrose percentage increases in improved globe-shaped beets of the future. Hence, this apparently desirable characteristic may not be as good as it looks.

Breeding Globe-shaped Sugarbeets

Globe-shaped beets recovered in the F_2 generation from a cross of SP 6822-0 x globe-shaped beets were "back-crossed" to SP 6922-0. The F_2 generation from this backcross was planted in the Beltsville nursery in 1972 to recover globe-shaped beets for further backcrossing. Only a few perfectly globe-shaped roots were found among 70 progenies planted in 5200 ft. of row. However, numerous root types intermediate between the globe-shape and spindle-shape were present. Also, many roots with extremely small crowns were in these plant populations. Figure 1 shows an ordinary multigerm sugarbeet root of SP 7122-0 and 2 selected roots which have small crowns and smooth roots relatively free of lateral roots and root hairs.

The weights of crowns and roots of these plants were as follows:

	Root weight	Crown weight	Ratio Root:Crown
Sugarbeet (on left)	2.17 lbs.	.78 lbs.	3:1
Selection (center)	1.36 lbs.	.12 lbs.	11:1
Selection (on right)	1.18 lbs.	.24 lbs.	5:1

These selected roots were set fairly deep in the soil being no more exposed than ordinary sugarbeets. Their smaller size is, of course, not particularly desirable since it would take more per acre to produce yields comparable to present commercial hybrids, and there is as yet no assurance that higher plant populations per acre would not result in still smaller roots.

The F_2 progenies from these backcrosses had leaf spot resistance comparable to present commercial hybrids. This amount of improvement is gratifying considering the extreme leaf spot susceptibility of the original globe-shaped beets 4 generations before. Selection emphasis in this material will be on root shape, yield, sucrose percentage and purity. Additional disease resistance will be realized with additional backcrosses to resistant sugarbeets and will be relatively easy to achieve compared with the other needed improvements.

One apparent globe-shaped 0-type was discovered in 1972. It has the red garden beet pigment and will be useful only as breeding material.

Fig. 1. Commercial type sugarbeet, SP 7122-0, and small-crowned smooth-root selections.

Sugarbeet Storage Decay

W. M. Bugbee

Selecting for resistance to phoma storage rot

In our continuing program to locate roots that are resistant to phoma storage rot, over 3,700 roots were inoculated after harvest this year. Betaseed, Inc. contributed 1,495 roots from 18 of their breeding lines. Four of these lines looked promising because about one-third of the roots appeared resistant. A total of 232 roots were saved from this group. American Crystal was able to contribute 177 roots of a pollinator they use in producing their new high sugar variety. Four of these roots appeared resistant. In addition, over 2,000 roots from 20 entries in a "variety test" are being evaluated for resistance. Resistant selections have been planted in the greenhouse for seed production, further progeny testing to confirm the resistance, and additional selection to improve the quality of resistance.

Effect of temperature on varietal response to *Phoma*

In earlier work, sugarbeets were inoculated and incubated at 10°C (50°F). This temperature was chosen because it is common in storage piles early in the campaign and it is the lowest temperature at which *Phoma* can do appreciable damage. But it was found that the rate of decay was too slow for a quick or practical evaluation of resistance. Also, the differences in disease reaction among varieties were not great. So the test was performed again at 15°C. At this temperature the rate of decay was more rapid and more varieties were susceptible. But the rank of the various cultivars and experimental lines remained about the same from one temperature to the next. For example, B-96 and 69MSH140 were near the top and American 2B and A-58 (a fodder beet) were near the bottom (Table 1).

Table 1. Disease rating of sugarbeet cultivars after storage roots were inoculated with *Phoma betae*.

Source	Entry	10C for 8 weeks	15C for 3 weeks
Betaseed Co.	B-96	57 a[a/]	114 a
Betaseed Co.	B-93	57 a	143 a
Great Western Sugar Co.	69-MSH-140	61 a	104 a
USDA, Ft. Collins	FC-701	64 a	139 a
Betaseed Co.	B-951	67 a	159 ab
Great Western Sugar Co.	68-MSH-155	72 a	122 a
Great Western Sugar Co.	A-1492	78 a	135 a
American Crystal Sugar Co.	3N	82 a	129 a
American Crystal Sugar Co.	3A	88 a	164 ab
Great Western Sugar Co.	GW-H36-70R	88 a	162 ab
Great Western Sugar Co.	GW-H45-70R	89 a	138 a
Holly Sugar Co.	HH-19	92 a	183 ab
American Crystal Sugar Co.	Improved 3T	93 a	167 ab
American Crystal Sugar Co.	3T	98 a	163 ab
Bush-Johnson Ltd.	Bush-Mono	102 a	179 ab
Great Western Sugar Co.	69-MSH-121	103 a	149 a
Holly Sugar Co.	HH-10	103 a	161 ab
Bush-Johnson Ltd.	Monofort	111 a	158 ab
American Crystal Sugar Co.	2B	126 ab	240 b
USDA, Ft. Collins	A58 (fodder)	216 b	179 ab

a/ Disease rating: sum of the length and width of lesion in mm multiplied by 5. Each value is an average of 24 roots. A rating of 30 indicates apparent immunity. Means followed by the same letter are not significantly different at 5%, based on Duncan's new multiple range test.

Another test was performed for a more critical examination of the effect of incubation temperatures on varietal response to decay. B-96 was chosen as the resistant and 2B as the susceptible cultivar based on the results from the 15°C test in Table 1. Here, the roots were quartered longitudinally and one quarter of a root was inoculated and placed in 10°, 15°, 20°, or 25°C, or all quarters were placed in one temperature. This removes the variability found among roots because it is similar to exposing a root to four different temperatures simultaneously. The data showed that as the temperature increased, decay increased as would be expected. But at 20-25°, the rate of decay leveled-off. Both cultivars appeared resistant at 10° or

15°C but at 20-25°C, B-96 was more susceptible than 2B. The differences between the two cultivars were evident after 2-3 weeks of incubation. So now all of the incubation and screening work is done at 23°C for 3 weeks. This reversal of varietal susceptibility has been noted in other host-pathogen combinations.

Table 2. Disease rating of two sugarbeet cultivars after roots were quartered longitudinally and inoculated with *Phoma betae*.

		Incubation temperature, °C			
Cultivar	Weeks	10°	15°	20°	25°
		four quarters within each temperature			
2B	1	75 lm	98 klm	210 gh	156 hijk
	2	170 hij	210 gh	472 bc	310 ef
	3	261 efg	322 e	592 a	529 ab
B-96	1	56 m	114 jklm	138 ijkl	245 fg
	2	134 ijkl	254 efg	272 efg	401 d
	3	202 ghi	410 cd	451 cd	551 a
		four quarters among temperatures			
2B	1	80 i	121 hi	210 efgh	182 gh
	2	192 fgh	255 efg	386 cd	305 de
	3	281 efg	391 cd	498 b	422 bc
B-96	1	72 i	139 hi	182 gh	218 efgh
	2	194 fgh	258 efg	468 bc	495 b
	3	286 ef	410 bc	658 a	701 a

a/ Disease rating: sum of the length and width of lesion in mm multiplied by 5. A rating of 30 indicates apparent immunity. Means followed by the same letter are not significantly different at the 5% level, Duncan's new multiple range test.

Effect of nitrogen fertility on storage decay1/

It is established that excess nitrogen fertility can increase impurity levels, lower the sucrose content and impair sucrose extraction from the juice. It is also known that impurities increase during storage and that susceptibility to decay increases with storage. The objectives of this study are to: 1) measure the reaction to *Phoma* of roots grown under different nitrogen levels; 2) determine the impurity levels in beets grown at different nitrogen fertility levels before and after storage and 3) determine if there is a correlation between the impurity level and amount of decay caused by *Phoma*. Roots were randomly collected from three nitrogen fertility demonstration plots and divided into two groups. The first group of roots was inoculated within 3 weeks after harvest. There were no differences in decay among the nitrogen treatments. The second group of roots were inoculated after 80 days of storage. The data has not been completely analyzed but preliminary results indicate that roots become more susceptible to *Phoma* during storage if they are grown under low nitrogen levels. This was especially evident from farm C where more decay occurred in roots that had an impurity index below 400 after 80 days storage. These roots also had the highest sucrose content. Analyses are now in progress to determine if there is a correlation between the amount of decay and certain components of the impurities.

1/ In cooperation with Mr. Ron Torkelson, Sugarbeet Extension Specialist, North Dakota State University.

Survival of *Phoma*

Phoma is seed borne and is a constant problem as a seedling disease organism if the seed is produced in a humid environment. A recent examination of seven commercial cultivars showed that an average of 9% of the seeds were infected with *Phoma* after 2 years of storage. The range was 2-24%. In our area, many seedlings survive attack by the fungus and continue to grow to a mature healthy looking root. But after harvest and storage decay can start. One obvious answer seems to be the use of fungicides on the seed to control the fungus but the only fungicides that are effective are the mercury containing compounds. These, of course, are dangerous and some are now illegal. Another answer might be the exclusive use of *Phoma* free seed which is produced in the dry climate of Arizona. But there is a high risk in depending on a single location for all seed production.

A better understanding of factors controlling the survival of Phoma in soil could aid in control. I have shown that Phoma can invade the roots of soybeans, alfalfa, oats and barley in the greenhouse. So, last year I planted small plots of wheat, oats, barley, sugarbeets, soybeans, alfalfa, and included black fallow and alfalfa and soybean fallow. The crops were plowed down and plant material of each of these crops was infected with Phoma in the laboratory, then wrapped in envelopes of fiberglass screen and buried 6" in these plots. Next spring and throughout the summer we will recover these samples and determine the survival of the fungus. We already know that Phoma can overwinter quite easily on infected sugarbeet tissue.

In order to assay field soil for the presence of Phoma we need a method of culturing it from samples of field soil. Phoma is unique in that it produces characteristic swellings and growth patterns when it contacts a glass surface. I used this feature to verify the presence of Phoma in soil samples from our disease garden at Fargo. But this is a very time consuming method. A simpler method would utilize a selective culture medium that would inhibit the growth of most common soil inhabitants except Phoma. Colonies then could simply be counted on culture plates. This has been done for other pathogens and we are currently working on this for Phoma.

Table 3. Phoma storage rot rating, sucrose content, and impurity index before and after storage of roots grown under different nitrogen levels.

Lbs. nitrogen per acre	Days stored at 5°C	Farm[a/] A Disease Rating	A % S	A Impurity Index	B Disease Rating	B % S	B Impurity Index	C Disease Rating	C % S	C Impurity Index
0	0	2.2[b]	15.6	693	2.3	15.0	578	2.3	17.2	387
	80	2.5	16.8	693	2.0	13.8	609	3.2	17.9	372
50	0	1.7	15.0	788	2.3	15.7	604	2.0	17.2	428
	80	2.4	14.3	950	2.4	14.4	862	3.2	18.0	372
100	0	2.1	15.0	789	2.3	14.3	672	2.0	17.1	424
	80	2.6	14.1	980	1.8	13.9	798	2.8	17.0	406
200	0	2.0	14.4	895	2.2	12.5	926	1.8	15.6	570
	80	2.6	14.5	1039	2.0	10.7	1674	1.6	15.9	518

a/ Pounds of nitrate-nitrogen in top 2 feet of soil before application of fertilizer: farm A, 63 lbs; farm B, 126 lbs; farm C, 12 lbs.

b/ Disease rating based on approximate diameter of rotted area: 1 = 3-5 mm; 2 = 5-10 mm; 3 = 10-15 mm; 4 = 15-20 mm; 5 = 20-25 mm; 6 = 25-30 mm.